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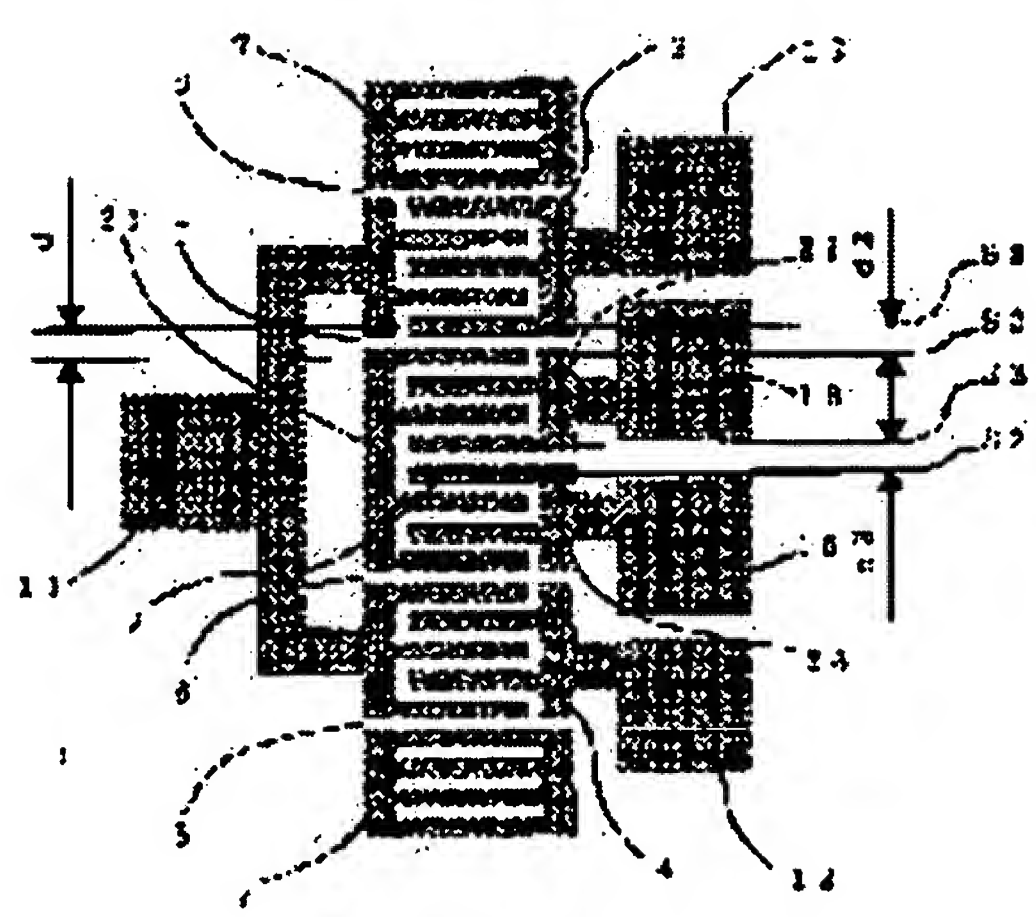
(54) SURFACE ACOUSTIC WAVE FILTER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surface acoustic wave filter that has an excellent insertion loss and has an excellent amplitude and phase balance characteristics.

SOLUTION: This invention provides the surface acoustic wave filter in which a balance signal electrode for balance input/output and an unbalance signal electrode for unbalance input/output is placed on a piezoelectric substrate 1, the balance signal electrode is formed by interdigitally opposing a plurality of interdigital signal electrodes among electrode fingers placed at both ends of one interdigital floating electrode or interdigital ground electrode and the interdigital signal electrodes adjacent to each other are opposed to each other in phase.



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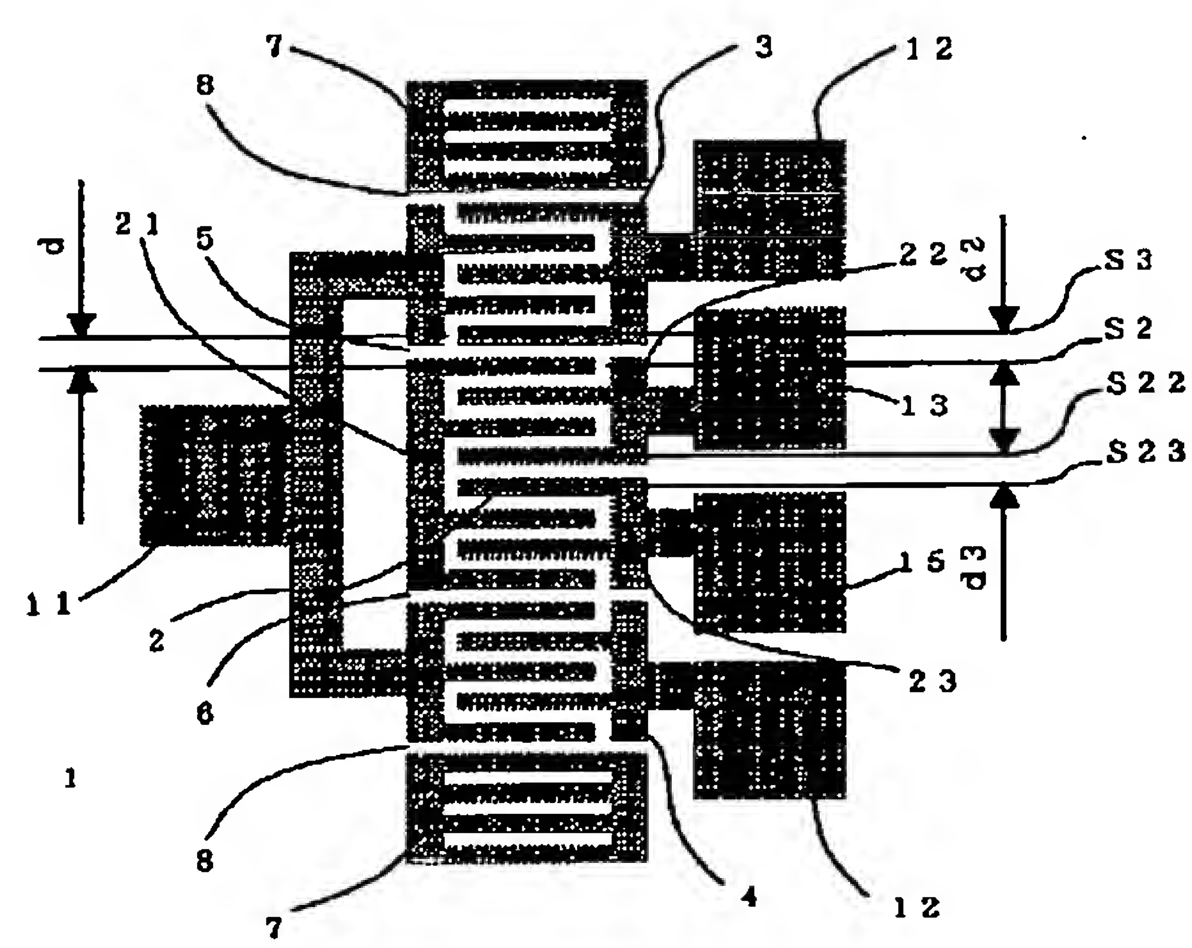
(54)【発明の名称】弾性表面波フィルタ

(57)【要約】
【課題】　挿入損失が良好であり、振幅および位相の平衡度の良好な弾性表面波フィルタを提供すること。
【解決手段】　圧電基板１上に、平衡入力または平衡出力を行う平衡信号電極と、不平衡出力または不平衡入力を行う不平衡信号電極とを配設し、平衡信号電極は、１つの櫛歯状浮き電極または櫛歯状接地電極に対し、該電極の両端に位置する電極指の間に、隣接させた複数の櫛歯状信号電極を噛み合わせるように対向させて成るとともに、隣合う櫛歯状信号電極が互いに逆位相である弾性表面波フィルタとする。



【特許請求の範囲】

【請求項１】　圧電基板上に、平衡入力または平衡出力を行う平衡信号電極と、不平衡出力または不平衡入力を行う不平衡信号電極とを配設して成る共振器型の弾性表面波フィルタであって、前記平衡信号電極は、１つの櫛歯状浮き電極または櫛歯状接地電極に対し、該電極の両端に位置する電極指の間に、隣接させた複数の櫛歯状信号電極を噛み合わせるように対向させて成るとともに、隣合う櫛歯状信号電極が互いに逆位相であることを特徴とする弾性表面波フィルタ。

【請求項２】　前記隣合う櫛歯状信号電極の端部に位置する電極指どうしが隣接していることを特徴とする請求項１に記載の弾性表面波フィルタ。

【請求項３】　前記平衡信号電極の中央から隣合う不平衡信号電極の中央までの平均電極指幅を、共振器全体の平均電極指幅よりも小さくしたことを特徴とする請求項１に記載の弾性表面波フィルタ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、圧電基板上に平衡入力または平衡出力を行う平衡信号電極と、不平衡出力または不平衡入力を行う不平衡信号電極とを備えて成る共振器型の弾性表面波フィルタに関するものである。

【０００２】

【従来技術とその課題】近年、移動体通信機器等の小型・軽量化および低コスト化のため、使用部品の削減が進められ、弾性表面波フィルタに新たな機能の付加が要求されてきている。その１つに不平衡入力－平衡出力型または平衡入力－不平衡出力型に構成できるようにするといった要求がある。ここで平衡入力または平衡出力とは、信号が２つの信号線路間の電位差として入力または出力するものをいい、各信号線路の信号は振幅が等しく、位相が逆相になっている。これに対して、不平衡入力または不平衡出力とは、信号がグランド電位に対する１本の線路の電位として入力または出力するものをいう。

【０００３】従来の弾性表面波フィルタは、一般的に不平衡入力－不平衡出力型弾性表面波フィルタ（以下、不平衡型弾性表面波フィルタという）であるため、弾性表面波フィルタの後段に接続される回路や電子部品が平衡入力型となっている場合は、弾性表面波フィルタと後段との間に、不平衡－平衡変換器（以下、バランともいう）を挿入した回路構成を採っていた。同様に弾性表面波フィルタ前段の回路や電子部品が平衡出力型となっている場合は、前段と弾性表面波フィルタとの間にバランを挿入した回路構成となっていた。

【０００４】現在、バランを削除するために、弾性表面波フィルタに不平衡－平衡変換機能または平衡－不平衡変換機能を持たせた、不平衡入力－平衡出力型弾性表面波フィルタまたは平衡入力－不平衡出力型弾性表面波フィルタ（以下、平衡型弾性表面波フィルタという）の実用化が進められている。

【０００５】例えば、複数個並設したＩＤＴ（Ｉｎｔｅｒ Ｄｉｇｉｔａｌ Ｔｒａｎｓｄｕｃｅｒ）電極の弾性表面波伝搬路の両端に、弾性表面波を効率よく共振させるための反射器電極が設けられた共振器型電極パターンにおいて、通過帯域内での振幅と位相の平衡度の向上が求められている。ここで、振幅と位相の平衡度とは、信号が２つの信号線路間の電位差として入力または出力するもので、各信号線路の信号の振幅の大きさが等しいほど振幅の平衡度が優れており、また、各信号の位相の差が１８０°に等しいほど位相の平衡度が優れているといえる。

【０００６】図３、４に従来までの平衡入出力に対応した共振器型弾性表面波フィルタを示す。圧電基板１０１上に配置させたＩＤＴ電極１０２は、一対の互いに対向させた櫛歯状電極に電界を加え、弾性表面波を励振させるものである。その原理により、ＩＤＴ電極１０２に入力信号を加えることで、励振された弾性表面波がＩＤＴ電極１０２の両側に位置する、出力信号用のＩＤＴ電極１０３，１０４に伝搬される。ＩＤＴ電極１０３、１０４の一方の櫛状電極から出力信号端子１１３、他方から出力信号端子１１５へ信号が伝わり平衡出力される。また、図４は２段接続することによりフィルタ特性の帯域外減衰量の向上ができる構成となっている。

【０００７】上記のような共振器型弾性表面波フィルタでは、ＩＤＴ電極１０３、１０４の対向する櫛状電極の電極本数、配置された位置、または、寄生容量を発生させる要因となる周辺の電極パターンなど構造が異なるために、出力信号端子１１３、１１５に伝わる信号が互いに振幅が異なり、また位相が逆相からずれてしまい、その結果、平衡度の劣化した共振器型弾性表面波フィルタしか得られなかった。

【０００８】近年、弾性表面波フィルタは各種通信機器の小形化、無調整化に一役を担っている。そして、通信機器の高周波数化、高機能化の進展にともない、弾性表面波フィルタの広帯域化の要求が益々増大してきている。例えば、９００ＭＨｚ帯携帯電話用のフィルタとしては、実効通過帯域幅３５ＭＨｚ以上（比帯域幅約３．７％以上）の高性能な広帯域フィルタが要求されている。なお、比帯域幅ＢＲは、ＢＲ＝ＢＷ／ｆｃ（ＢＷは帯域内挿入損失が３ｄＢにおける通過帯域幅、ｆｃは帯域内挿入損失が３ｄＢにおける通過帯域の中心周波数）であらわすことができる。

【０００９】このような広帯域化を実現するために、従来、様々な方法が提案されている。例えば、３個のＩＤＴ（Ｉｎｔｅｒ Ｄｉｇｉｔａｌ Ｔｒａｎｓｄｕｃｅｒ）電極（１対の櫛歯状電極を互いに対向させた電極）を設け、縦１次モードと縦３次モードを利用した、いわゆる２重モード弾性表面波共振子フィルタが知られてい

る。

【００１０】図３に示すように、両端に位置する反射器電極１０７により弾性表面波が反射され、反射器電極１０７，１０７間で定在波となる。この定在波のモードには、３つのＩＤＴ電極により１次モードとその高次（３次）モードが含まれる。これらのモードで発生する共振周波数で通過特性が得られるため、共振周波数の間隔を制御することにより、通過帯域を広くさせることができる。なお、図中、１０５，１０６はＩＤＴ電極間部位、１０８はＩＤＴ電極と反射器電極間部位、１１１は入力信号端子、１１２は接地端子、１１３，１１５は出力信号端子である。

【００１１】従来、このモード間の周波数制御に、全てのＩＤＴ電極を同じピッチＬにし、かつ、中央およびその両側に位置するＩＤＴ電極の端部（ＩＤＴ電極間部位）１０５，１０６における電極指中心間の間隔ｄの制御により、前記のモード間の周波数を制御する方法がとられていた。また、出力信号用のＩＤＴ電極に容量を付加して周波数を制御していた。

【００１２】このため、従来の２重モード弾性表面波共振器フィルタでは、例えば圧電基板としてＬｉＴａＯ３単結晶の基板を用いた場合、比帯域幅（中心周波数に対する通過帯域幅の値）は約０．４０％程度（特開平１－２３１４１７号公報を参照）、または高々２％程度しか得られていなかった（特開平４－４０７０５号公報を参照）。また、最大の帯域幅で３．７％が実現されているが（特開平７－５８５８１号公報を参照）、前記したように、システムの占有帯域幅の比率が３．７％であるため、フィルタとしては温度変動と作製時のばらつき変動の周波数分が必要であることから、広い通過帯域幅が要求されている携帯電話等の通信機器への適用には問題があった。

【００１３】そこで本発明は、平衡型として動作可能で振幅と位相の平衡度が良好で高品質な弾性表面波フィルタ、さらには挿入損失が良好であり、通過帯域幅の広い弾性表面波フィルタとして機能できる、優れた弾性表面波フィルタを提供することを目的とする。

【００１４】

【課題を解決するための手段】前記目的を達成するために、本発明の共振器型の弾性表面波フィルタは、圧電基板上に、平衡入力または平衡出力を行う平衡信号電極と、不平衡出力または不平衡入力を行う不平衡信号電極とを配設して成り、前記平衡信号電極は、１つの櫛歯状浮き電極または櫛歯状接地電極に対し、該電極の両端に位置する電極指の間に、隣接させた複数の櫛歯状信号電極を噛み合わせるように対向させて成るとともに、隣合う櫛歯状信号電極が互いに逆位相であることを特徴とする。また、隣合う櫛歯状信号電極の端部に位置する電極指どうしが隣接していることを特徴とする。また、平衡信号電極の中央から隣合う不平衡信号電極の中央までの平均電極指幅を共振器全体の平均電極指幅よりも小さくしたことを特徴とする。

【００１５】

【発明の実施の形態】以下、本発明の実施形態を模式的に図示した図面に基づいて詳細に説明する。

【００１６】図１に本発明に係る弾性表面波フィルタの平面図を示す。不平衡信号電極であるＩＤＴ電極３，４および平衡信号電極であるＩＤＴ電極２を複数配置させ、その両端に反射器電極７を載置させることは、従来構造と同様であるが、本発明の構造では、ＩＤＴ電極２が、１つの櫛歯状浮き電極または櫛歯状接地電極２１に対し、その電極の両端に位置する電極指の間に、隣接させた複数の櫛歯状信号電極２２，２３を噛み合わせるように対向させて成るとともに、隣合う櫛歯状信号電極２２、２３が互いに逆位相に成るように構成され、それぞれの電極部が平衡信号電極として形成されている。上記構造により振幅および位相バランスを制御していることを特徴としている。なお、ＩＤＴ電極２，３，４および反射器電極７の電極指の本数は数本～数１００本にもおよぶため、その形状を簡略化して図示している。以下、弾性表面波フィルタを示す図面においては、全て同様に簡略化して図示するものとする。

【００１７】ここで、３個のＩＤＴ電極２～４のうち、中央に配置されたＩＤＴ電極２は不平衡入力用または不平衡出力用のＩＤＴ電極であり、その両端に配置されたＩＤＴ電極３，４はそれぞれ平衡入力用または平衡出力用のＩＤＴ電極である。出力用のＩＤＴ電極を形成している１対の電極のうち、一方を出力１とすると、他方が出力１に対して振幅が同じ大きさで位相が逆相になっている出力２となり、平衡型の動作を行う。

【００１８】不平衡入出力部の信号線Ｓ３と平衡出入力部の信号線Ｓ２の間隔ｄ２とフィルタ特性の相関を調査したところ、ｄ２が大きくなるほど互いの電磁界の干渉が小さくなり、その結果平衡出入力部の振幅と位相の平衡度が改善され、逆にｄ２が小さくなるほど弾性表面波の伝搬損失が小さくなり、その結果フィルタ特性の挿入損失が小さくなり、最適な構造はｄ２が弾性表面波の波長をλとするとλ＋ｄに等しくなるところでもっとも挿入損失が小さく、振幅と位相の平衡度もよくなることが判明した。

【００１９】また２つの平衡出入力部の信号線Ｓ２２，Ｓ２３の間隔ｄ３についても調査したところ、隣合う櫛歯状信号電極の端部に位置する電極指どうしが隣接し、ｄ３がλ／２に近づくほどフィルタ特性の挿入損失が小さくなることが判明した。すなわち、本発明の構造にすることにより、フィルタ特性の挿入損失、振幅と位相の平衡度ともに優れた弾性表面波フィルタを提供することができることが判明した。

【００２０】次に、本発明の電極構成の変形例を図２、９、１０、１１に示す。

【００２１】図２は共振器型フィルタを２段接続した弾性表面波フィルタである。不平衡信号電極であるＩＤＴ電極９１へ不平衡信号が入力され、ＩＤＴ電極９２から不平衡信号が出力される。そして、ＩＤＴ電極９２と隣の共振器型フィルタの不平衡信号電極３，４が接続される。上記構造によりフィルタ特性の帯域外減衰量を大きく向上させせることができる。

【００２２】図９は、平衡信号電極２の中央から隣合う不平衡信号電極３，４の中央までのＩＤＴ電極間部位５，６の平均電極指幅を共振器全体の平均電極指幅よりも小さくしたことを特徴とする。上記構造によりフィルタ特性の通過帯域幅を制御することができる。

【００２３】図１０は共振器型フィルタを２段接続し、平衡信号電極であるＩＤＴ電極２の中央から隣合う不平衡信号電極であるＩＤＴ電極３，４の中央までのＩＤＴ電極間部位５，６の平均電極指幅を共振器全体の平均電極指幅よりも小さくしたことを特徴とする。上記構造によりフィルタ特性の帯域外減衰量を大きく向上させることができ、さらに、フィルタ特性の通過帯域幅を制御することができる。

【００２４】かくして、前記のような条件を満足するＩＤＴ電極構造の弾性表面波フィルタによれば、ＩＤＴ電極対数が最適化された組み合わせとなり、その結果、比帯域幅、振幅および位相の平衡度の特性が良好な品質的に優れたフィルタを作製することができるのである。

【００２５】図１１は平衡信号電極の櫛歯状電極を４つ噛み合わせたことを特徴とする。これにより、電極を４つ使用することにより設計パラメータを増やすことができ、より要求仕様に適した設計を行えることができる。

【００２６】なお、図１においては弾性表面波フィルタを１セクションの共振器で構成したが、これに限定されるものではなく、共振器を２個以上縦続接続した弾性表面波フィルタやＩＤＴ電極を５個以上並べた弾性表面波フィルタにおいても本発明を適用することができる。

【００２７】また、図２、９、１０、１１の弾性表面波フィルタの電極構造においてもこれに限定されるものではなく、２つの反射器電極の間に少なくとも３つのＩＤＴ電極を配するとともに、これら３つのＩＤＴ電極のうち中央に位置するＩＤＴ電極を不平衡入力部または不平衡出力部とし、かつ両端に位置するＩＤＴ電極を平衡出力部または平衡入力部としたものであれば、多数段に構成したりすることもできる。

【００２８】また、弾性表面波フィルタ用の圧電基板１として、３６°±３°ＹカットＸ伝搬タンタル酸リチウム単結晶、４２°±３°ＹカットＸ伝搬タンタル酸リチウム単結晶、６４°±３°ＹカットＸ伝搬ニオブ酸リチウム単結晶、４１°±３°ＹカットＸ伝搬リチウム単結晶、４５°±３°ＸカットＺ伝搬四ホウ酸リチウム単結晶は電気機械結合係数が大きく、かつ、周波数温度係数が小さいため圧電基板として好ましい。圧電基板の厚みは０．１mm～０．５mm程度がよく、０．１mm未満では圧電基板がもろくなり、０．５mm超では材料コストと部品寸法が大きくなり、使用できない。

【００２９】また、ＩＤＴ電極２，３，４は、Ａｌもしくはアルミ合金（Ａｌ－Ｃｕ系、Ａｌ－Ｔｉ系）からなり、蒸着法、スパッタ法、またはＣＶＤ法などの薄膜形成法により形成する。電極厚みは０．１μm～０．５μm程度とすることが弾性表面波フィルタとしての特性を得るうえで好適である。

【００３０】さらに、本発明に係る弾性表面波フィルタの電極および圧電基板上の弾性表面波伝搬部にＳｉ、ＳｉＯ２、ＳｉＮｘ、Ａｌ２Ｏ３を保護膜として形成して、導電性異物による通電防止や耐電力向上を行ってもかまわない。

【００３１】

【実施例】本発明に係る弾性表面波フィルタを具体的に試作した実施例について説明する。

【００３２】３８．７°ＹカットのＬｉＴａＯ３単結晶の圧電基板上に、図１に示すようなＡｌ（９９ｗｔ％）－Ｃｕ（１ｗｔ％）による微細電極パターンを形成した。ＩＤＴ電極２の対数は１６対、ＩＤＴ電極３，４の対数は１１対、電極の周期はＩＤＴ電極２，３，４ともに２．１μm、ＩＤＴ電極２－３間または２－４間のＩＤＴ電極の端部における電極指中心間の間隔ｄは３．３μmとした。パターン作製には、スパッタリング装置、縮小投影露光機（ステッパー）、およびＲＩＥ（Ｒｅａｃｔｉｖｅ Ｉｏｎ Ｅｔｃｈｉｎｇ）装置によりフォトリソグラフィを行った。

【００３３】まず、基板材料をアセトン・ＩＰＡ等によって超音波洗浄し、有機成分を落とした。次に、クリーンオーブンによって充分に基板乾燥を行った後、電極の成膜を行った。電極の成膜にはスパッタリング装置を使用し、Ａｌ－Ｃｕ１ｗｔ％合金から成る材料を用いた。このときの電極膜厚は約０．２μmとした。

【００３４】次に、フォトレジストを約０．５μmの厚みにスピンコートし、縮小投影露光装置（ステッパー）により、所望形状にパターニングを行ない、現像装置にて不要部分のフォトレジストをアルカリ現像液で溶解させ、所望パターンを表出した後、ＲＩＥ（Ｒｅａｃｔｉｖｅ Ｉｏｎ Ｅｔｃｈｉｎｇ）装置により電極膜のエッチングを行ないパターンニングを終了し、梯子型弾性表面波フィルタを構成する弾性表面波共振器の電極パターンを得た。

【００３５】この後、前記電極の所定領域上に保護膜を作製した。すなわち、ＣＶＤ（Ｃｈｅｍｉｃａｌ Ｖａｐｏｒ Ｄｅｐｏｓｉｔｉｏｎ）装置により、電極パターンおよび圧電基板上にＳｉＯ２を約０．０２μmの厚みに形成した。その後、フォトリソグラフィによってフォトレジストのパターニングを行ない、ＲＩＥ装置等でワイヤボンディング用窓開け部のエッチングを行ない、

保護膜パターンを完成した。

【００３６】次に、基板をダイシング線に沿ってダイシング加工を施し、チップごとに分割した。そして、各チップをダイボンド装置にてピックアップし、シリコーンを主成分とする樹脂を用いパッケージ内に接着した。この後、約１６０℃の温度において乾燥・硬化させた。パッケージは３mm角の積層構造のものを用いた。

【００３７】次に、３０μmφＡｕワイヤをパッケージの電極部とチップ上のＡｌ電極パッド上にボールボンディングした後、リッドをパッケージに被せ、封止機にて溶接封止して弾性表面波フィルタを完成した。なお、チップ上のグランド電極は各々分離して配線し、Ａｕボールボンディングにてパッケージ上のグランド電極にボンディングを行った。

【００３８】比較用サンプルとして図３に示すような微細電極パターンも上記と同様な工程で作製を行った。ＩＤＴ電極１０２の対数は１６対、ＩＤＴ電極１０３，１０４の対数は１１対、電極の周期はＩＤＴ電極１０２，１０３，１０４ともに２．１μm、ＩＤＴ電極１０２－１０３間または１０２－１０４間のＩＤＴ電極の端部における電極指中心間の間隔ｄは３．３μmとした。

【００３９】次に、本実施例における弾性表面波フィルタの特性測定を行った。０ｄＢmの信号を入力し、周波数８４２．５MHｚ～１０４２．５MHｚ、測定ポイント数８０１ポイントの条件および周波数１０MHｚ～６GHｚ、測定ポイント４０１ポイントの条件にて測定した。サンプル数は３０個、測定機器はアジレント・テクノロジー社製ネットワークアナライザ８７５３Ｄである。

【００４０】通過帯域近傍の周波数特性グラフを図５、６に示す。ここで、図５はフィルタの伝送特性を表す挿入損失の周波数依存性（図中５１）および反射信号の大きさを評価する比率ＶＳＷＲ（Ｖｏｌｔａｇｅ　Ｓｔａｎｄｉｎｇ　Ｗａｖｅ　Ｒａｔｉｏ）の周波数依存性（図中５２）を示すグラフである。また、図６はフィルタ特性の平衡度を示すグラフであり、出力信号端子１３から出力された挿入損失の周波数特性と出力信号端子１５から出力された挿入損失の周波数特性の差を振幅の平衡度とする。また、出力信号端子１３から出力された位相の周波数特性と出力信号端子１５から出力された位相の周波数特性の差から１８０°を差し引いた値を位相の平衡度とする。振幅の平衡度が０ｄＢであり位相の平衡度が０°であるほど弾性表面波フィルタの平衡度が優れていると評価できる。

【００４１】本発明品のフィルタ特性は非常に良好であった。図６に示すように、通過帯域内９２５MHｚ～９６０MHｚの振幅の平衡度６１は約±０．７ｄＢ以下であり、および位相の平衡度６２は約±７°以下であった。これに対して、比較サンプルとして作製した従来構造の弾性表面波フィルタは、図７、８に示すとおり、通過帯域内９２５MHｚ～９６０MHｚの振幅の平衡度８１は約±１．４ｄＢ以下であり、位相の平衡度８２は約±１５°以下であった。それぞれ約０．７ｄＢ、約８°の改善が見られた。また、本発明品の通過帯域の挿入損失５１は約２．４ｄＢ以下、ＶＳＷＲ５２は２．７以下であるのに対し、従来品は挿入損失７１が約３．１ｄＢ以下、ＶＳＷＲ７２は３．６以下であり、それぞれ約０．７ｄＢ、０．９の改善が見られた。

【００４２】また、弾性表面波フィルタの小型化が要求されているため上記実施例の弾性表面波フィルタをフリップチップ実装により作製し、評価を行った。すなわち、保護膜パターンを形成した後、バンプ形成装置によりバンプ形成用電極パターンにＡｕのバンプを形成した。次に、ダイシングにより、弾性表面波素子を個々に切り出した。次に、２．５×２．０mm角のセラミックパッケージにフリップチップボンディング装置により、個々に切り出した弾性表面波素子を１つ、セラミックパッケージ内に接着し、Ｎ２雰囲気中でベークを行った。次に、封止装置によりパッケージに金属製のキャップを被せてパッケージ内を密封し、弾性表面波フィルタを作製した。上記構造のフィルタの特性を測定した結果、上記と同様な結果が得られることを確認できた。

【００４３】

【発明の効果】以上説明したように、本発明の弾性表面波フィルタは、共振器型の弾性表面波フィルタであって、平衡信号電極は、１つの櫛歯状浮き電極または櫛歯状接地電極に対し、該電極の両端に位置する電極指の間に、隣接させた複数の櫛歯状信号電極を噛み合わせるように対向させて成るとともに、隣合う櫛歯状信号電極が互いに逆位相であることを特徴とする。上記構造の特に櫛歯状浮き電極または櫛歯状接地電極が平衡信号電極の両端に位置するような構成により、不平衡電極と平衡電極の電磁界の干渉を小さくすることができ、その結果、平衡信号を制御することができ、振幅および位相の平衡度が良好な品質的に優れた弾性表面波フィルタを実現することができる。

【００４４】また、本発明の弾性表面波フィルタは、隣合う櫛歯状信号電極の端部に位置する電極指どうしが隣接していることを特徴とする。上記構造の電極指の間隔を制御することにより平衡信号電極２２，２３の位相の差を１８０°に近づけることができ、その結果、位相の平衡度が良好な品質的に優れた弾性表面波フィルタを実現することができるまた、本発明の弾性表面波フィルタは、平衡信号電極の中央から隣合う不平衡信号電極の中央までの平均電極指幅を共振器全体の平均電極指幅よりも小さくしたことを特徴とする。上記構造の平均電極指幅をそれぞれ変化させることにより弾性表面波の縦１次モードと縦３次モードを制御することができる。

【００４５】以上により、フィルタ特性の通過帯域幅を広帯域化した品質的に優れた弾性表面波フィルタを実現

することができる。

【図面の簡単な説明】

【図１】本発明の弾性表面波フィルタの構成例を模式的に示す平面図である。

【図２】本発明の弾性表面波フィルタの２段接続の構成例を模式的に示す平面図である。

【図３】従来の弾性表面波フィルタの構成例を示す平面図である。

【図４】従来の弾性表面波フィルタの２段接続の構成例を示す平面図である。

【図５】本発明の弾性表面波フィルタにおける通過帯域近傍の周波数特性を示すグラフである。

【図６】本発明の弾性表面波フィルタにおける通過帯域近傍の振幅および位相の平衡度を示すグラフである。

【図７】従来の弾性表面波フィルタにおける通過帯域近傍の周波数特性を示すグラフである。

【図８】従来の弾性表面波フィルタにおける通過帯域近傍の振幅および位相の平衡度を示すグラフである。

【図９】本発明に係る１段構成の弾性表面波フィルタを模式的に示す電極構成図である。

【図１０】本発明に係る２段接続の弾性表面波フィルタを模式的に示す電極構成図である。

【図１１】本発明に係る弾性表面波フィルタの変形例を模式的に示す電極構成図である。

【符号の説明】

１，１０１　：圧電基板

２，３，４，９１，９２，１０２，１０３，１０４　：ＩＤＴ電極

５，６，１０５，１０６　：ＩＤＴ電極間部位

７，１０７　：反射器電極

８，１０８　：ＩＤＴ電極と反射器電極間部位

１１，１１１　：入力信号端子

１２，１１２　：接地端子

１３，１５，１１３，１１５　：出力信号端子

２１　：接地端子または電気的浮き電極

２２，２３　：櫛歯状信号電極

５１，７１　：挿入損失の周波数特性

５２，７２　：ＶＳＷＲの周波数特性

６１，８１　：振幅の平衡度の周波数特性

６２，８２　：位相の平衡度の周波数特性

Ｓ２，Ｓ２２，Ｓ２３　：平衡出入力部の信号線

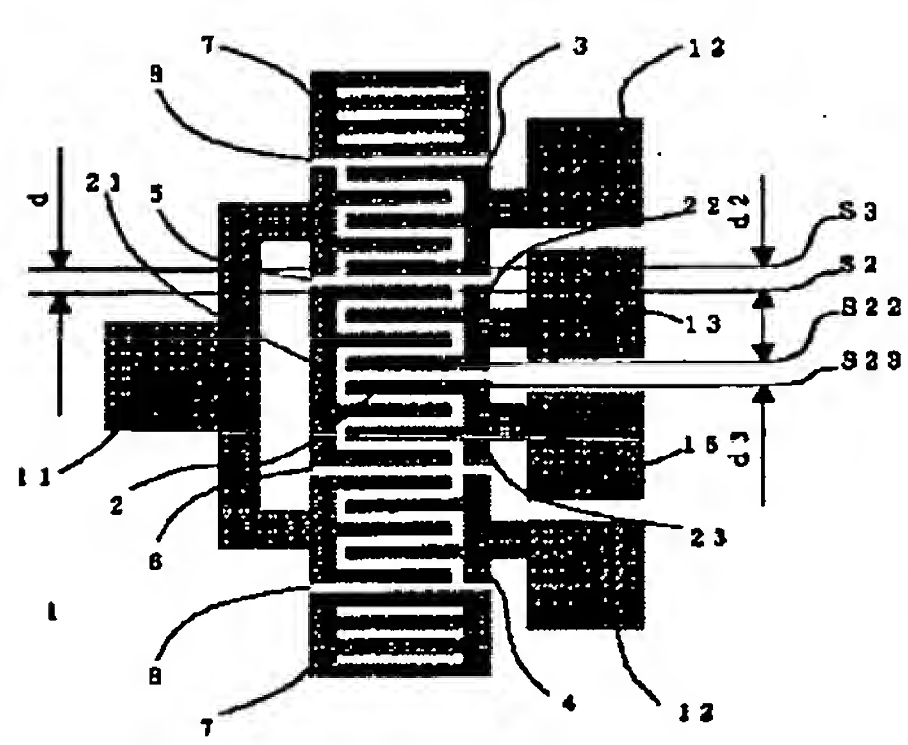
Ｓ３　：不平衡入出力部の信号線

ｄ　：電極指中心間の間隔

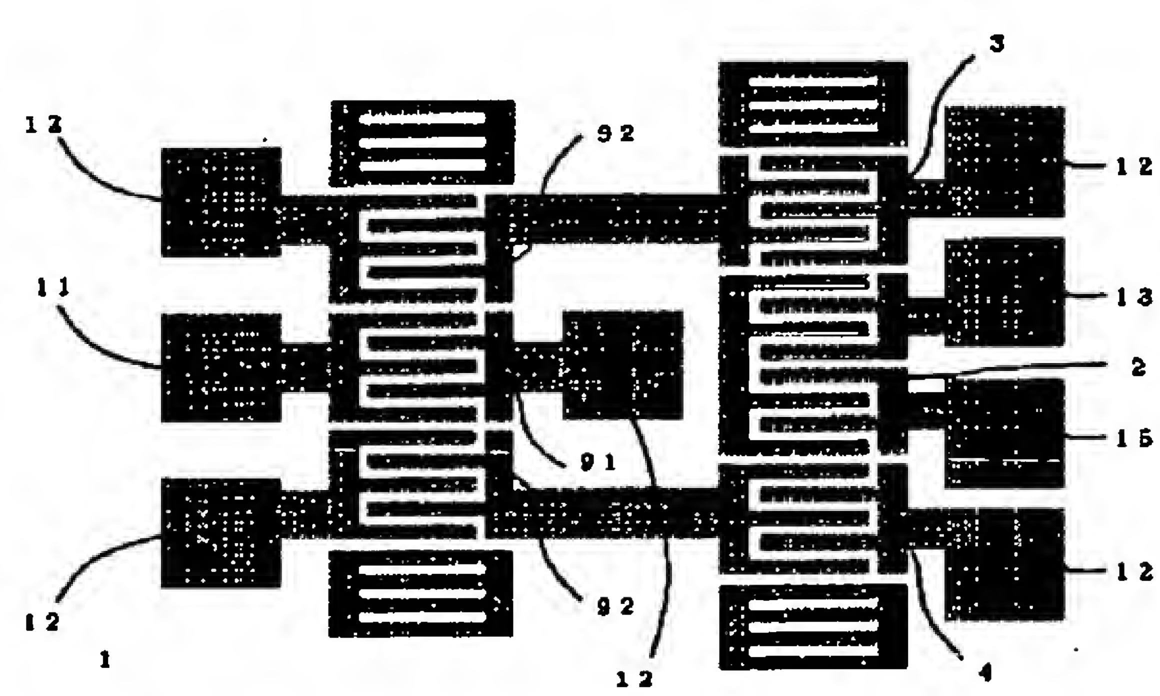
ｄ２　：Ｓ２，Ｓ３の間隔

ｄ３　：Ｓ２２，Ｓ３３の間隔

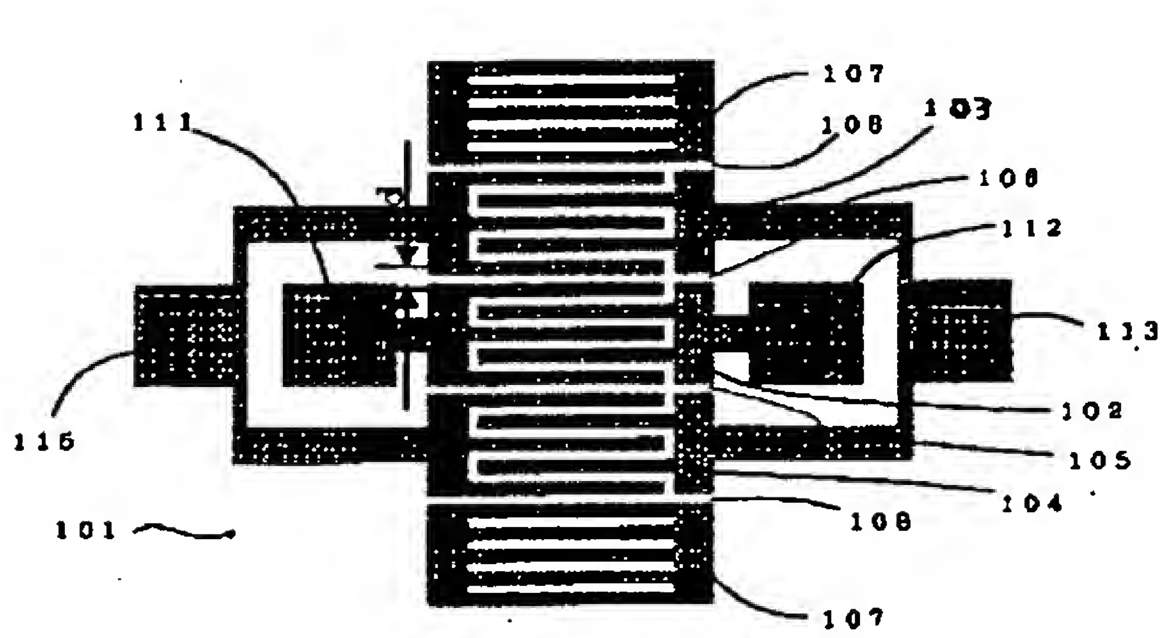
【図１】



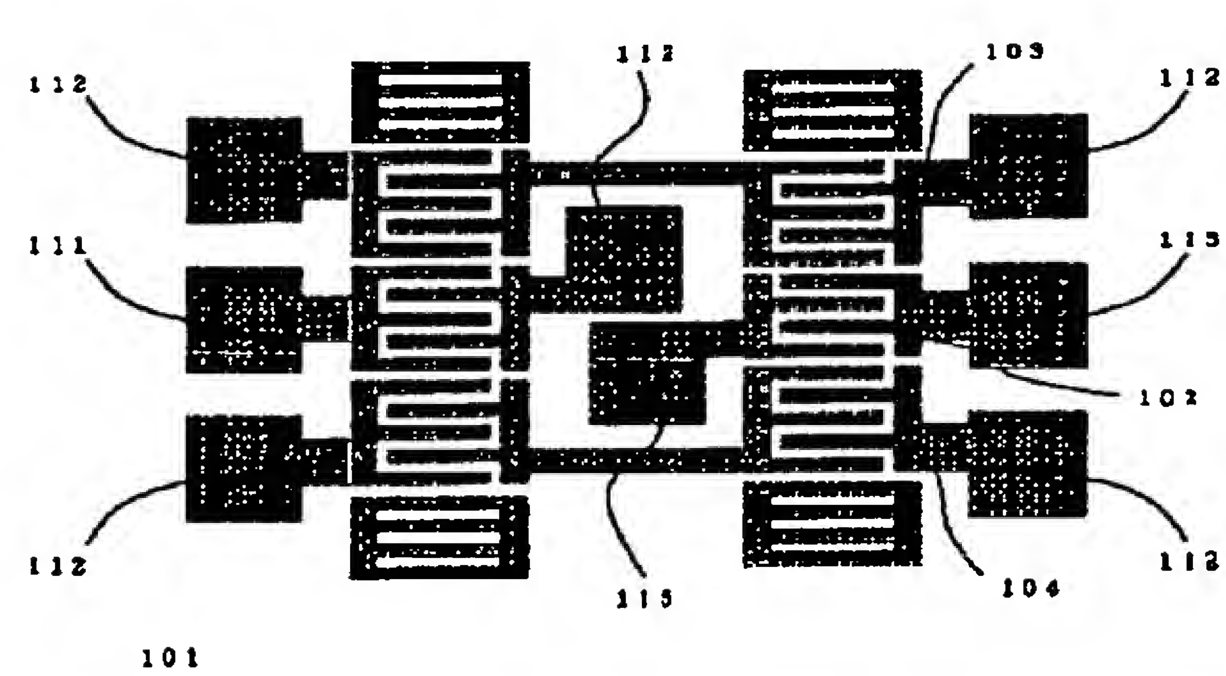
【図２】



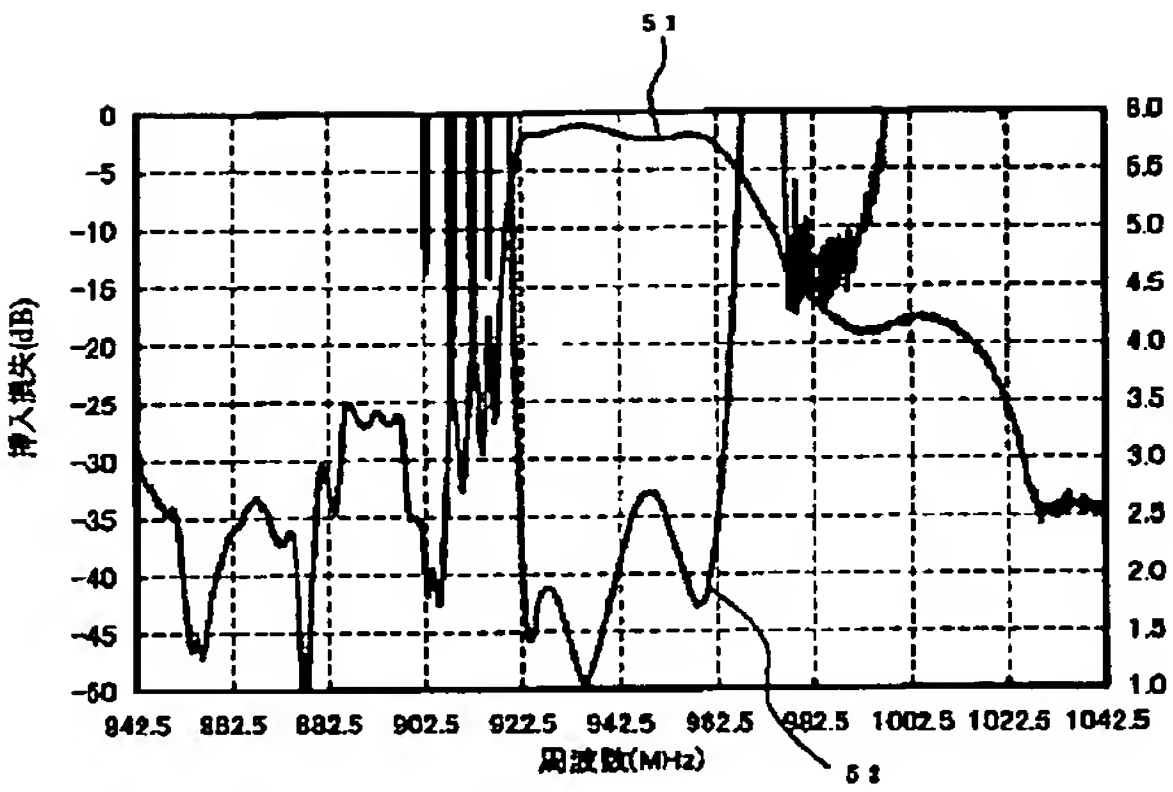
【図３】



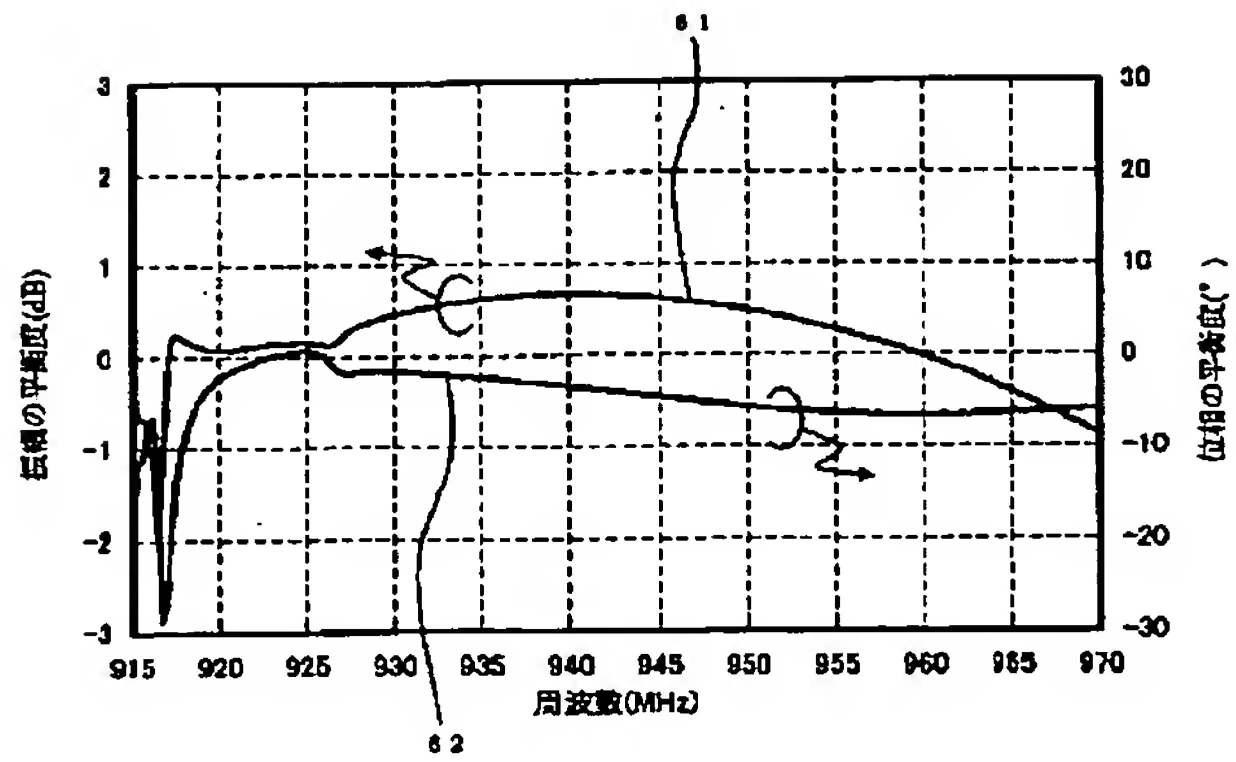
【図４】



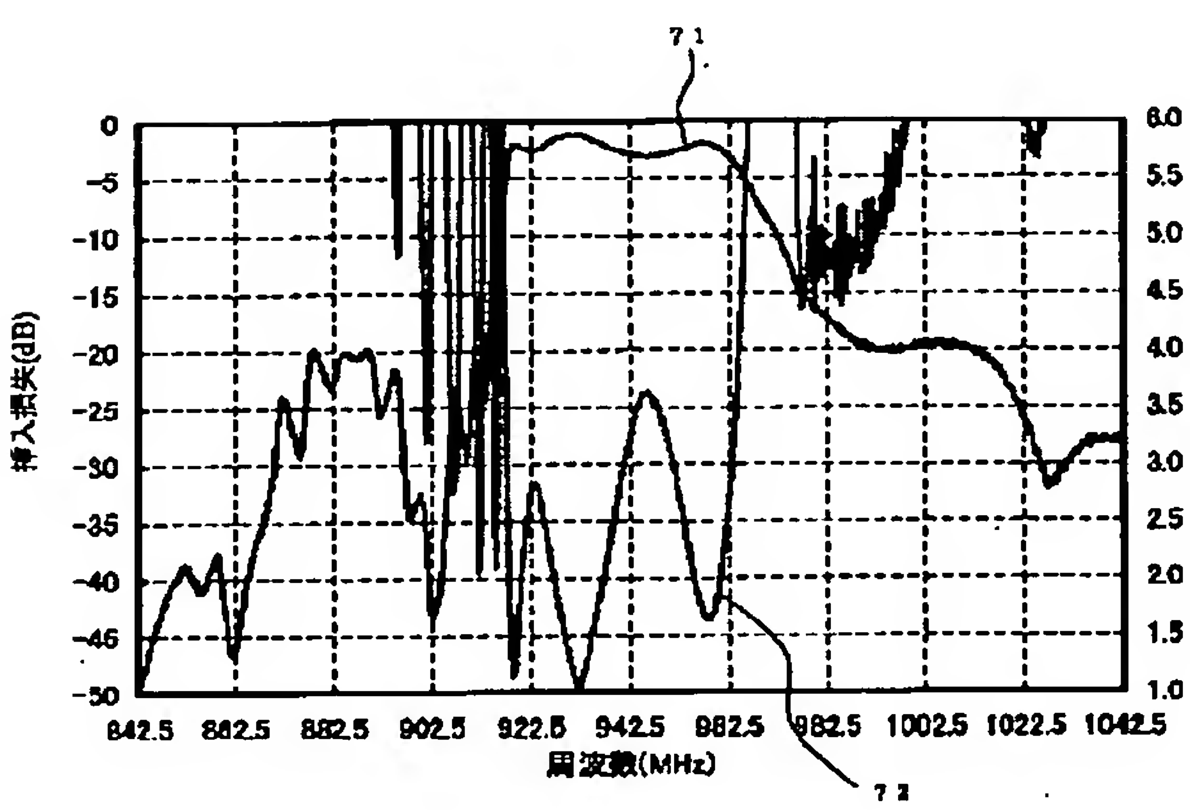
【図５】



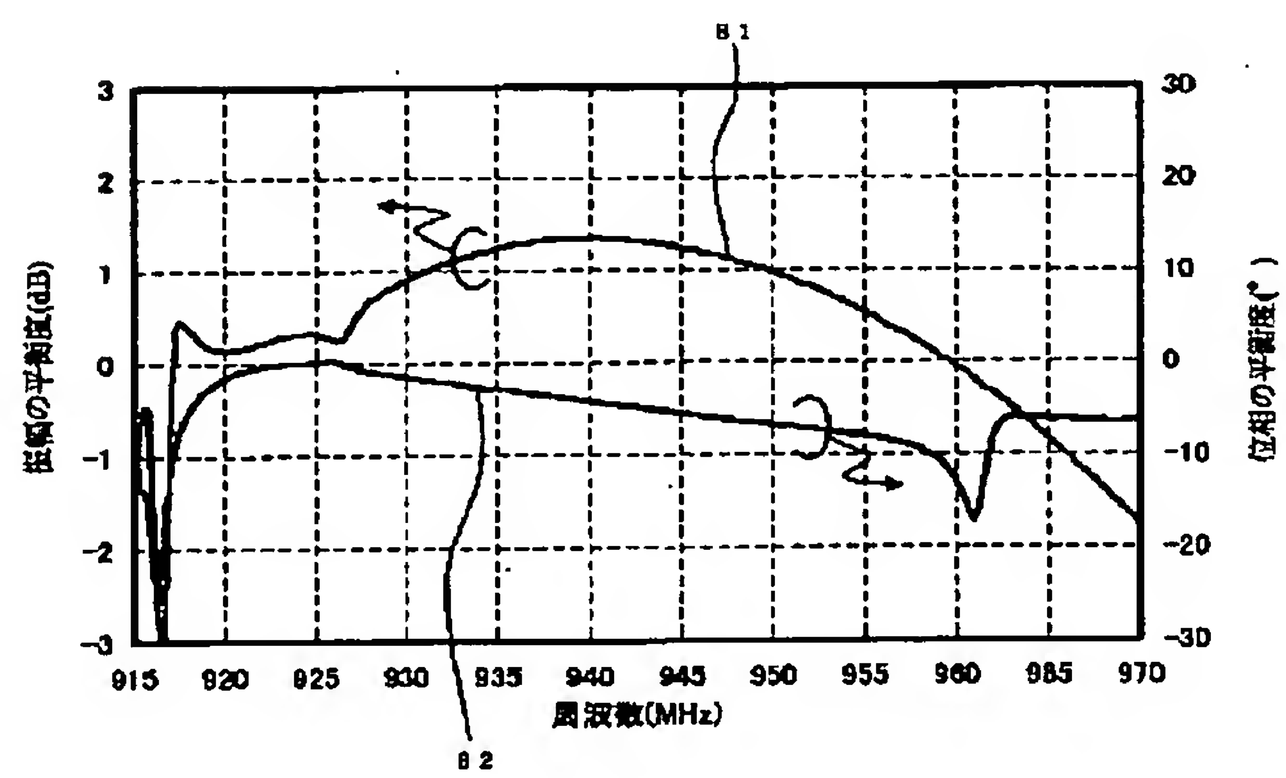
【図６】



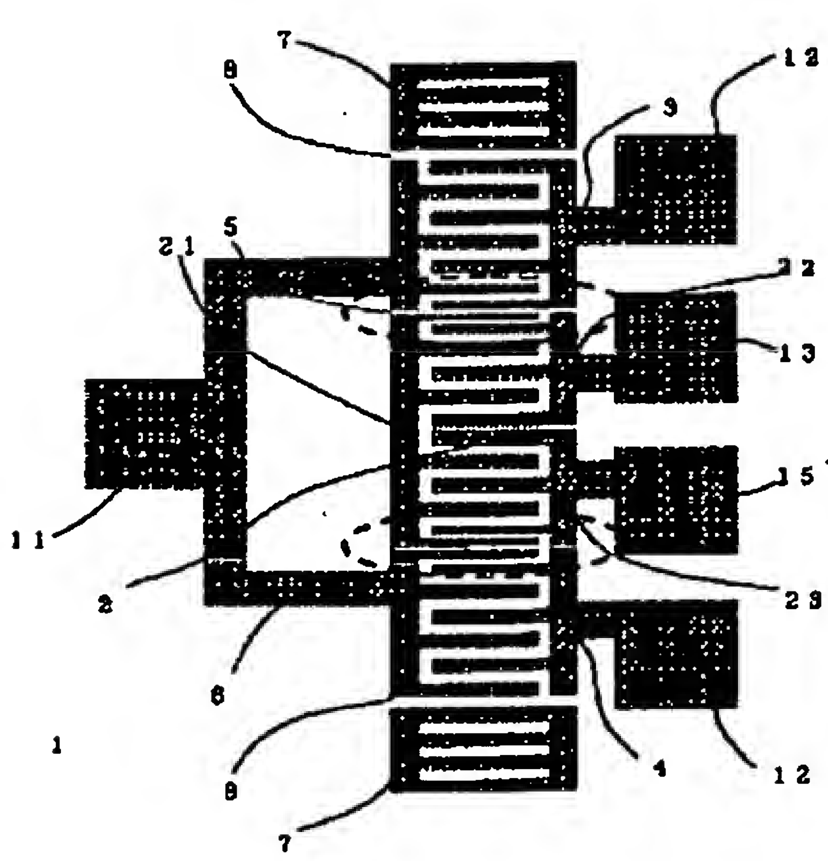
【図７】



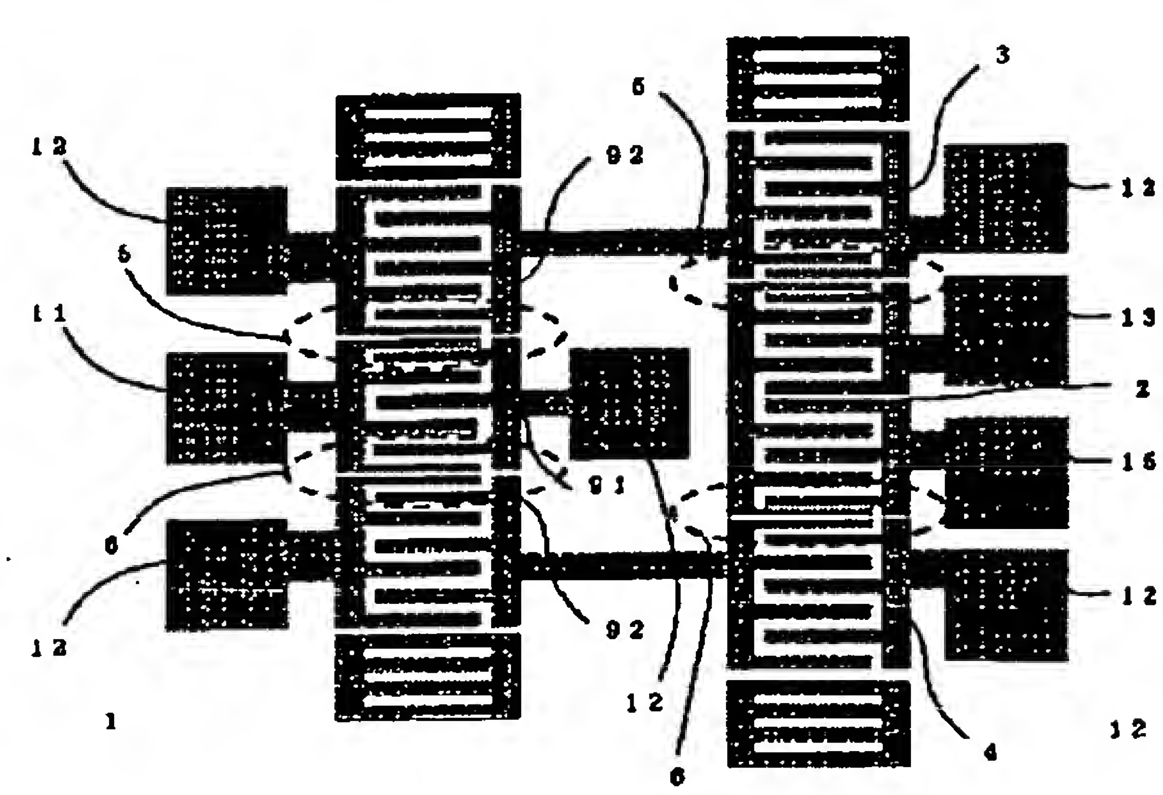
【図８】



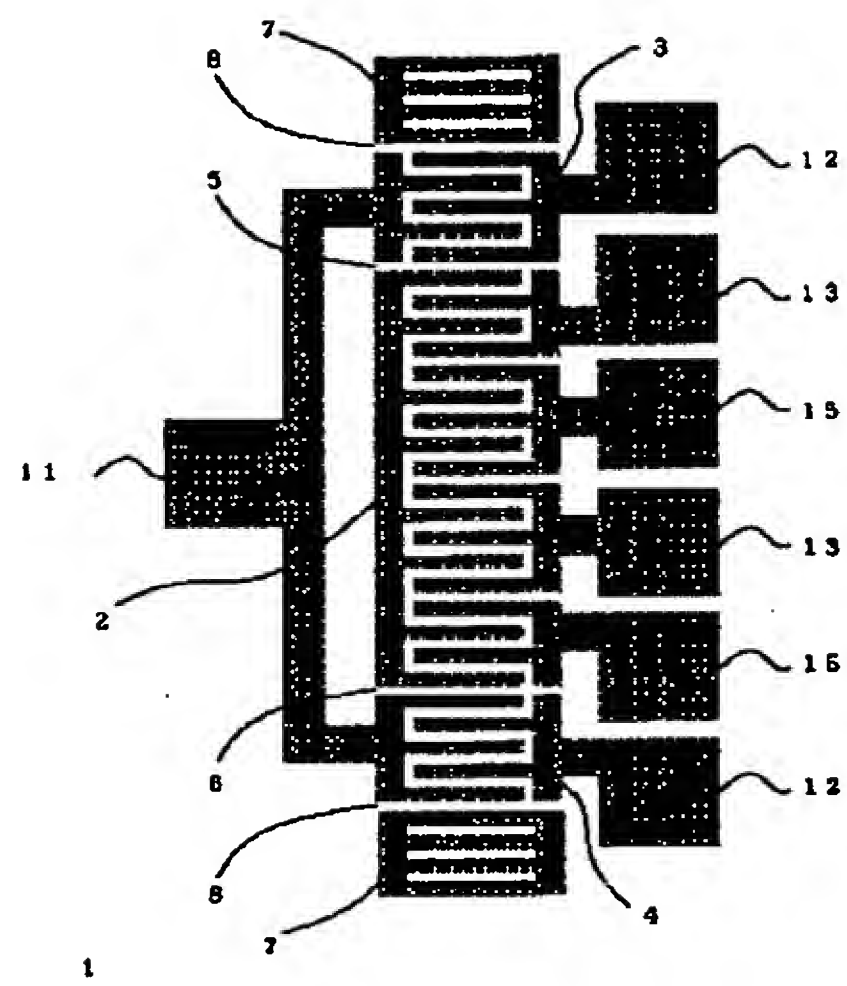
【図９】



【図１０】



【図１１】



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(71)Applicant : KYOCERA CORP

(72)Inventor : ITO MIKI

OTSUKA KAZUHIRO

(54) SURFACE ACOUSTIC WAVE FILTER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surface acoustic wave filter that has an excellent insertion loss and has an excellent amplitude and phase balance characteristics.

SOLUTION: This invention provides the surface acoustic wave filter in which a balance signal electrode for balance input/output and an unbalance signal electrode for unbalance input/output is placed on a piezoelectric substrate 1, the balance signal electrode is formed by interdigitally opposing a plurality of interdigital signal electrodes among electrode fingers placed at both ends of one

interdigital floating electrode or interdigital ground electrode and the interdigital signal electrodes adjacent to each other are opposed to each other in phase.

LEGAL STATUS

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[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

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[Date of registration]

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[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]

[Claim 1] It is the surface acoustic wave filter of the resonator mold which arranges the balanced signal electrode which performs a balanced input or a balanced output, and the unbalance signal electrode which performs an unbalanced output or an unbalanced input, and changes on a piezo-electric substrate. While said balanced signal electrode makes it counter so that two or more ctenidium-like signal electrodes made to adjoin may be engaged and changes between the electrode fingers located in the ends of this electrode to one ctenidium-like float electrode or a ctenidium-like earth electrode The surface acoustic wave filter characterized by a ****** ctenidium-like signal electrode being an opposite phase mutually.

[Claim 2] The surface acoustic wave filter according to claim 1 characterized by the electrode fingers located in the edge of said ****** ctenidium-like signal electrode adjoining.

[Claim 3] The surface acoustic wave filter according to claim 1 characterized by making the average electrode digit from the center of said balanced signal electrode to the center of a ****** unbalance signal electrode smaller than the average electrode digit of the whole resonator.

[Translation done.]

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the surface acoustic wave filter of the resonator mold which is equipped with the balanced signal electrode which performs a balanced input or a balanced output, and the unbalance signal electrode which performs an unbalanced output or an unbalanced input, and changes on a piezo-electric substrate.

[0002]

[Description of the Prior Art] In recent years, for small and lightweight-izing of mobile communication equipment etc., and low-cost-izing, the cutback of activity components is advanced and addition of a new function has been required of a surface acoustic wave filter. One of them has a demand of enabling it to constitute in an unbalanced input-balanced output mold or a balanced input-unbalanced output mold. A balanced input or a balanced output means what a signal inputs or outputs as the potential difference between two signal-line ways here, the signal of each signal-line way has the equal amplitude, and the phase is an opposite phase. On the other hand, an unbalanced input or an unbalanced output means what a signal inputs or outputs as potential of one line over ground potential.

[0003] The conventional surface acoustic wave filter had taken the circuitry which inserted the unbalance-balanced converter (henceforth a balun) between a surface acoustic wave filter and the latter part, when the circuit and electronic parts which are connected to the latter part of a surface acoustic wave filter had become a balanced input mold, since it was generally an unbalanced input-unbalanced output mold surface acoustic wave filter (henceforth an unbalance

mold surface acoustic wave filter). When the circuit and electronic parts of the surface acoustic wave filter preceding paragraph had become a balanced output mold similarly, it had become circuitry which inserted the balun between the preceding paragraph and a surface acoustic wave filter.

[0004] In order to delete current and a balun, utilization of the unbalanced input-balanced output mold surface acoustic wave filter which gave the unbalance-balance conversion function or balanced - unbalance conversion function to the surface acoustic wave filter, or a balanced input-unbalanced output mold surface acoustic wave filter (henceforth a balanced type surface acoustic wave filter) is advanced.

[0005] For example, in the resonator mold electrode pattern with which the reflector electrode for resonating a surface acoustic wave efficiently was prepared in the ends of the surface acoustic wave propagation path of the installed IDT (Inter Digital Transducer) electrode, improvement in the amplitude in a passband and the unbalance of a phase is called for. Here, a signal inputs or outputs the amplitude and the unbalance of a phase as the potential difference between two signal-line ways, the unbalance of the amplitude is excellent, so that its magnitude of the amplitude of the signal of each signal-line way is equal, and it can be said that the unbalance of a phase is excellent, so that the difference of the phase of each signal is equal to 180 degrees.

[0006] The resonator mold surface acoustic wave filter corresponding to the balanced I/O to the former is shown in drawing 3 and 4. The IDT electrode 102 arranged on the piezo-electric substrate 101 adds electric field to the ctenidium-like electrode made to counter mutually [a couple], and excites a surface acoustic wave. By the principle, the excited surface acoustic wave spreads by applying an input signal to the IDT electrode 102 to the IDT electrode 103,104 for output signals located in the both sides of the IDT electrode 102. The propagation balanced output of the signal is carried out from the output signal terminal 113 and another side from one pectinate form electrode of the IDT electrodes 103 and 104 to the output signal terminal 115. Moreover, drawing 4

has composition which can perform improvement in the magnitude of attenuation of a filter shape out of band, when two steps connect.

[0007] Since structures, such as an electrode pattern of the circumference used as the electrode number of the pectinate form electrode with which the IDT electrodes 103 and 104 counter, the arranged location, or the factor which generates parasitic capacitance, differed, with the above resonator mold surface acoustic wave filters, only the resonator mold surface acoustic wave filter with which amplitude differed [the signal which gets across to the output signal terminals 113 and 115] mutually, the phase shifted from the opposite phase, consequently unbalance deteriorated was obtained.

[0008] In recent years, the surface acoustic wave filter is bearing a part to the miniaturization of various communication equipment, and no adjusting-ization. And the demand of broadband-izing of a surface acoustic wave filter has been growing increasingly with progress of high-frequency-izing of communication equipment, and advanced features. For example, as a filter for 900MHz band cellular phones, the highly efficient broad band filter with an effective pass band width of 35MHz or more (about 3.7% or more of fractional band width) is demanded. In addition, fractional band width BR can be expressed with BR=BW/fc (pass band width [in / BW / in band interpolation close loss / 3dB], center frequency of a passband [in / fc / in band interpolation close loss / 3dB]).

[0009] In order to realize such broadband-ization, various approaches are proposed conventionally. For example, three IDT (Inter Digital Transducer) electrodes (electrode which one pair of ctenidium-like electrodes were made to counter mutually) are prepared, and the so-called double mode surface acoustic wave resonator filter using primary length mode and 3rd length mode is known.

[0010] As shown in drawing 3 , a surface acoustic wave is reflected by the reflector electrode 107 located in ends, and it becomes a standing wave between the reflector electrodes 107,107. The primary mode and its high order (3rd order) mode are contained in the mode of this standing wave with three IDT electrodes. Since a passage property is acquired with the resonance frequency generated in

these modes, a passband can be made large by controlling spacing of resonance frequency. In addition, for an IDT inter-electrode part and 108, as for an input signal terminal and 112, an IDT electrode, a reflector inter-electrode part, and 111 are [105,106 / an earth terminal and 113,115] output signal terminals among drawing.

[0011] Conventionally, the approach of controlling the frequency between the aforementioned modes by control of the spacing d of the electrode finger center to center in the edge (IDT inter-electrode part) 105,106 of the IDT electrode which makes all IDT electrodes the same pitch L, and is located in the frequency control between this mode at a center and its both sides was taken. Moreover, capacity was added to the IDT electrode for output signals, and the frequency was controlled.

[0012] For this reason, with the conventional double mode surface acoustic wave resonator filter, when the substrate of LiTaO3 single crystal was used, for example as a piezo-electric substrate, fractional band width (value of the pass band width to center frequency) was obtained only about 0.40% (see JP,1-231417,A) or at most about 2% (see JP,4-40705,A). Moreover, although 3.7% was realized with the greatest bandwidth (see JP,7-58581,A), since the ratio of the occupancy bandwidth of a system was 3.7% as described above, there was a problem in application to communication equipment, such as a cellular phone with which large pass band width is demanded from the amount of [of temperature fluctuation and the dispersion fluctuation at the time of production] frequency being required as a filter.

[0013] Then, this invention can operate as a balanced type and aims at offering a surface acoustic wave filter with the good and quality unbalance of the amplitude and a phase, and the outstanding surface acoustic wave filter which an insertion loss is still better and can function as surface acoustic wave filters with wide pass band width.

[0014]

[Means for Solving the Problem] In order to attain said object, the surface

acoustic wave filter of the resonator mold of this invention On a piezo-electric substrate, the balanced signal electrode which performs a balanced input or a balanced output, and the unbalance signal electrode which performs an unbalanced output or an unbalanced input are arranged, and it changes. Said balanced signal electrode While making it counter so that two or more ctenidium-like signal electrodes made to adjoin may be engaged and changing between the electrode fingers located in the ends of this electrode to one ctenidium-like float electrode or a ctenidium-like earth electrode, it is characterized by a ****** ctenidium-like signal electrode being an opposite phase mutually. Moreover, it is characterized by the electrode fingers located in the edge of a ****** ctenidium-like signal electrode adjoining. Moreover, it is characterized by making the average electrode digit from the center of a balanced signal electrode to the center of a ****** unbalance signal electrode smaller than the average electrode digit of the whole resonator.

[0015]

[Embodiment of the Invention] Hereafter, it explains to a detail based on the drawing which illustrated the operation gestalt of this invention typically.

[0016] The top view of the surface acoustic wave filter applied to this invention at drawing 1 is shown. Although it is the same as that of structure conventionally to carry out two or more arrangement of the IDT electrode 2 which is the IDT electrodes 3 and 4 and the balanced signal electrode which are an unbalance signal electrode, and to make the reflector electrode 7 lay in the ends With the structure of this invention, the IDT electrode 2 between the electrode fingers located in the ends of the electrode to one ctenidium-like float electrode or the ctenidium-like earth electrode 21 While making it counter so that two or more ctenidium-like signal electrodes 22 and 23 made to adjoin may be engaged and changing, it is constituted so that the ****** ctenidium-like signal electrodes 22 and 23 may grow into an opposite phase mutually, and each polar zone is formed as a balanced signal electrode. It is characterized by controlling the amplitude and phase balance by the above-mentioned structure. In addition, the

number of the electrode finger of the IDT electrodes 2, 3, and 4 and the reflector electrode 7 is simplifying and illustrating the configuration in order to attain to several - no less than 100 numbers. Hereafter, in the drawing in which a surface acoustic wave filter is shown, it shall simplify similarly and all shall be illustrated.

[0017] Here, the IDT electrode 2 arranged in the center among three IDT electrodes 2-4 is an object for unbalanced inputs, or an IDT electrode for unbalanced outputs, and the IDT electrodes 3 and 4 arranged to the ends are an object for balanced inputs, or an IDT electrode for balanced outputs, respectively. If one side is an output 1 among one pair of electrodes which form the IDT electrode for an output, another side will serve as the output 2 from which the phase is an opposite phase in the magnitude with the same amplitude to an output 1, and will operate a balanced type.

[0018] The place which investigated the spacing d2 of the signal line S3 of the unbalance I/O section, and the signal line S2 of the balanced appearance input section, and correlation of a filter shape, Interference of such mutual electromagnetic field that d2 becomes large becomes small, and, as a result, the amplitude of the balanced appearance input section and the unbalance of a phase are improved. Conversely, the propagation loss of a surface acoustic wave becomes small, so that d2 becomes small, and as a result, the insertion loss of a filter shape becomes small. The optimal structure had the smallest insertion loss in the place which becomes equal to lambda+d, when d2 set wavelength of a surface acoustic wave to lambda, and it became clear that the unbalance of the amplitude and a phase also became good.

[0019] Moreover, when investigated also about the spacing d3 of the signal lines S22 and S23 of the two balanced appearance input sections, it became clear that the insertion loss of a filter shape became small, so that the electrode fingers located in the edge of a ****** ctenidium-like signal electrode adjoined and d3 approached lambda/2. That is, it became clear by making it the structure of this invention that the surface acoustic wave filter excellent in the insertion loss of a filter shape and the unbalance of the amplitude and a phase could be offered.

[0020] Next, the modification of the electrode configuration of this invention is shown in drawing 2 , and 9, 10 and 11.

[0021] Drawing 2 is the surface acoustic wave filter which connected two steps of resonator mold filters. An unbalance signal is inputted into the IDT electrode 91 which is an unbalance signal electrode, and an unbalance signal is outputted from the IDT electrode 92. And the IDT electrode 92 and the unbalance signal electrodes 3 and 4 of the next resonator mold filter are connected. The magnitude of attenuation of a filter shape out of band can be greatly raised according to the above-mentioned structure.

[0022] Drawing 9 is characterized by making the average electrode digit of the IDT inter-electrode parts 5 and 6 from the center of the balanced signal electrode 2 to the center of the ****** unbalance signal electrodes 3 and 4 smaller than the average electrode digit of the whole resonator. The pass band width of a filter shape is controllable by the above-mentioned structure.

[0023] It is characterized by for drawing 10 having connected two steps of resonator mold filters, and making smaller than the average electrode digit of the whole resonator the average electrode digit of the IDT inter-electrode parts 5 and 6 from the center of the IDT electrode 2 which is a balanced signal electrode to the center of the IDT electrodes 3 and 4 which are ****** unbalance signal electrodes. The magnitude of attenuation of a filter shape out of band can be greatly raised according to the above-mentioned structure, and the pass band width of a filter shape can be controlled further.

[0024] according to the surface acoustic wave filter of the IDT electrode structure of satisfying the above conditions in this way -- an IDT electrode -- the filter became the combination by which the logarithm was optimized, consequently the property of the unbalance of fractional band width, the amplitude, and a phase excelled [filter] in the good quality target is producible.

[0025] Drawing 11 is characterized by engaging four ctenidium-like electrodes of a balanced signal electrode. Thereby, by using four electrodes, a design parameter can be increased and the design which was more suitable for

requirement specification can be performed.

[0026] In addition, although the surface acoustic wave filter was constituted from a resonator of one section in drawing 1 , it is not limited to this and this invention can be applied also in the surface acoustic wave filter which put in order the surface acoustic wave filter which carried out two or more piece cascade connection of the resonator, and five or more IDT electrodes.

[0027] Moreover, it is not what is limited also to setting in the electrode structure of drawing 2 and the surface acoustic wave filter of 9, 10, and 11. While arranging at least three IDT electrodes between two reflector electrodes If the IDT electrode which makes the IDT electrode located in the center among these three IDT electrodes the unbalanced input section or the unbalanced output section, and is located in ends is made into the balanced output section or the balanced input section, it can also constitute in an a large number stage.

[0028] Moreover, as a piezo-electric substrate 1 for surface acoustic wave filters, since [that its electromechanical coupling coefficient is large and] a 36 degrees **3 degreeY cut X propagation lithium tantalate single crystal, a 42 degrees **3 degreeY cut X propagation lithium tantalate single crystal, a 64 degrees **3 degreeY cut X propagation lithium niobate single crystal, a 41 degrees **3 degreeY cut X propagation lithium single crystal, and a 45-degreeX [**3 degree] cut Z propagation tetraboric-acid lithium single crystal have the small frequency temperature coefficient, they are desirable as a piezo-electric substrate. The thickness of a piezo-electric substrate has 0.1mm - about 0.5 goodmm, and by less than 0.1mm, a piezo-electric substrate cannot become weak, by 0.5mm **, ingredient cost and a components dimension become large and it cannot be used.

[0029] Moreover, the IDT electrodes 2, 3, and 4 consist of aluminum or an aluminum alloy (an aluminum-Cu system, aluminum-Ti system), and are formed by the thin film forming methods, such as vacuum deposition, a spatter, or a CVD method. Electrode thickness is suitable when being referred to as 0.1 micrometers - about 0.5 micrometers acquires the property as a surface acoustic

wave filter.

[0030] Furthermore, Si, SiO2, SiNx, and aluminum 2O3 may be formed in the surface acoustic wave propagation section on the electrode of the surface acoustic wave filter concerning this invention, and a piezo-electric substrate as a protective coat, and the energization prevention and the improvement in power-proof by the conductive foreign matter may be performed.

[0031]

[Example] The example which made concretely the surface acoustic wave filter concerning this invention as an experiment is explained.

[0032] On the piezo-electric substrate of LiTaO3 single crystal of 38.7 degreeY cut, the detailed electrode pattern by aluminum(99wt%)-Cu (1wt%) as shown in drawing 1 was formed. As for the logarithm of the IDT electrode 2, the spacing d of the electrode finger center to center in the edge of the IDT electrode between 2.1 micrometers and the IDT electrode 2-3 or between 2-4 set the period of 11 pairs and an electrode to 3.3 micrometers for the IDT electrodes 2, 3, and 4, as for the logarithm of 16 pairs and the IDT electrodes 3 and 4. A sputtering system, a reduced-projection-exposure machine (stepper), and RIE (Reactive Ion Etching) equipment performed the photolithography in pattern production.

[0033] First, the substrate ingredient was cleaned ultrasonically by the acetone, IPA, etc., and the organic component was dropped. Next, after clean oven fully performed substrate desiccation, membrane formation of an electrode was performed. The sputtering system was used for membrane formation of an electrode, and the ingredient which consists of an aluminum-Cu1wt% alloy was used. The electrode layer thickness at this time could be about 0.2 micrometers.

[0034] Next, the spin coat of the photoresist was carried out to the thickness of about 0.5 micrometers, after having carried out patterning to the request configuration, dissolving the photoresist of a garbage with the alkali developer with the developer and expressing a request pattern with a cutback projection aligner (stepper), the electrode layer was etched with RIE (Reactive Ion Etching) equipment, pattern NINGU was ended, and the electrode pattern of the surface

acoustic wave resonator which constitutes a ladder mold surface acoustic wave filter was obtained.

[0035] Then, the protective coat was produced on the predetermined field of said electrode. That is, SiO2 was formed on the electrode pattern and the piezo-electric substrate with CVD (Chemical Vapor Deposition) equipment at the thickness of about 0.02 micrometers. Then, by the photolithography, patterning of a photoresist was performed, ******** for wirebonding was etched with the RIE system etc., and the protective coat pattern was completed.

[0036] Next, dicing processing was performed along with the dicing line, and the substrate was divided for every chip. And each chip was taken up with die bond equipment, and it pasted up in the package using the resin which uses silicone as a principal component. Then, desiccation and hardening of were done in the temperature of about 160 degrees C. The package used the thing of the laminated structure of 3mm angle.

[0037] Next, after carrying out ball bonding of the 30micrometerphiAu wire on aluminum electrode pad on the polar zone of a package, and a chip, the lid was put on the package, welding closure was carried out with the closure machine, and the surface acoustic wave filter was completed. In addition, it dissociated respectively, and the grand electrode on a chip wired, and performed bonding to the grand electrode on a package in Au ball bonding.

[0038] The detailed electrode pattern as shown in drawing 3 as a sample for a comparison also produced at the same process as the above. As for the logarithm of the IDT electrode 102, the spacing d of the electrode finger center to center in the edge of the IDT electrode between 2.1 micrometers and the IDT electrode 102-103 or between 102 -104 set the period of 11 pairs and an electrode to 3.3 micrometers for the IDT electrode 102,103,104, as for the logarithm of 16 pairs and the IDT electrode 103,104.

[0039] Next, property measurement of the surface acoustic wave filter in this example was performed. The 0dBm signal was inputted and it measured on the conditions of a 842.5MHz - 1042.5 MHz frequency and 801 points of measure

point numbers and the frequency of 10MHz - 6GHz, and the conditions of 401 points of measure points. A measurement size is 30 pieces and measuring equipment is network analyzer by horse mackerel RENTO technology company 8753D.

[0040] The frequency-characteristics graph near the passband is shown in drawing 5 and 6. Here, drawing 5 is a graph which shows frequency dependent [of the ratio VSWR (Voltage Standing Wave Ratio) which evaluates frequency dependent / of the insertion loss showing the transmission characteristic of a filter / (51 in drawing), and the magnitude of a reflective signal] (52 in drawing). Moreover, drawing 6 is a graph which shows the unbalance of a filter shape, and makes the unbalance of the amplitude the difference of the frequency characteristics of the insertion loss outputted from the output signal terminal 13, and the frequency characteristics of the insertion loss outputted from the output signal terminal 15. Moreover, let the value which deducted 180 degrees from the difference of the frequency characteristics of the phase outputted from the output signal terminal 13, and the frequency characteristics of the phase outputted from the output signal terminal 15 be the unbalance of a phase. It can be estimated that the unbalance of a surface acoustic wave filter is excellent, so that the unbalance of the amplitude is 0dB and the unbalance of a phase is 0 degree.

[0041] The filter shape of this invention article was dramatically good. As shown in drawing 6 , in the passband, the unbalance 61 with an amplitude of 925MHz - 960MHz was about **0.7dB or less, and the unbalance 62 of a phase was about **7 degrees or less. On the other hand, conventionally which was produced as a comparison sample, in the passband, the unbalance 81 with an amplitude of 925MHz - 960MHz was about **1.4dB or less, and the unbalance 82 of a phase was about **15 degrees or less as the surface acoustic wave filter of structure was shown in drawing 7 and 8. The improvement (about 0.7dB and about 8 degrees) was found, respectively. Moreover, to the passband insertion loss 51 of this invention article being about 2.4dB or less, and VSWR52 being 2.7 or less, conventionally, the insertion loss 71 of about 3.1dB or less and VSWR72 is 3.6 or

less, and, as for elegance, the improvement of about 0.7dB and 0.9 was found, respectively.

[0042] Moreover, since the miniaturization of a surface acoustic wave filter was demanded, the surface acoustic wave filter of the above-mentioned example was produced by flip chip mounting, and it evaluated. That is, after forming a protective coat pattern, the bump of Au was formed in the electrode pattern for bump formation with bump formation equipment. Next, the surface acoustic element was separately started by dicing. Next, with flip-chip-bonding equipment, the surface acoustic element started separately was pasted up in one and a ceramic package, and BEKU was performed to the ceramic package of 2.5x2.0mm angle in N2 ambient atmosphere. Next, the metal cap was put on the package with the sealing arrangement, the inside of a package was sealed, and the surface acoustic wave filter was produced. As a result of measuring the property of the filter of the above-mentioned structure, it has checked that the same result as the above was obtained.

[0043]

[Effect of the Invention] As explained above, the surface acoustic wave filter of this invention is a surface acoustic wave filter of a resonator mold, and a balanced signal electrode is characterized by a ****** ctenidium-like signal electrode being an opposite phase mutually while it is made to counter so that two or more ctenidium-like signal electrodes made to adjoin may be engaged and changes between the electrode fingers located in the ends of this electrode to one ctenidium-like float electrode or a ctenidium-like earth electrode. Interference of the electromagnetic field of an unbalance electrode and a balanced electrode can be made small, consequently a balanced signal can be controlled by configuration of the above-mentioned structure in which a ctenidium-like float electrode or a ctenidium-like earth electrode is especially located in the ends of a balanced signal electrode, and the surface acoustic wave filter the unbalance of the amplitude and a phase excelled [filter] in the good quality target can be realized.

[0044] Moreover, the surface acoustic wave filter of this invention is characterized by the electrode fingers located in the edge of a ****** ctenidium-like signal electrode adjoining. The surface acoustic wave filter of this invention is characterized by the thing which can realize the surface acoustic wave filter could bring the difference of the phase of the balanced signal electrodes 22 and 23 close to 180 degrees, consequently the unbalance of a phase excelled [filter] in the good quality target and for which the average electrode digit from the center of a balanced signal electrode to the center of a ****** unbalance signal electrode was made smaller than the average electrode digit of the whole resonator by controlling spacing of the electrode finger of the above-mentioned structure again. The primary length mode of a surface acoustic wave and 3rd length mode are controllable by changing the average electrode digit of the above-mentioned structure, respectively.

[0045] The surface acoustic wave filter which broadband-ized pass band width of a filter shape and which was excellent in quality is realizable with the above.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the top view showing typically the example of a configuration of the surface acoustic wave filter of this invention.

[Drawing 2] It is the top view showing typically the example of a configuration of two-step connection of the surface acoustic wave filter of this invention.

[Drawing 3] It is the top view showing the example of a configuration of the conventional surface acoustic wave filter.

[Drawing 4] It is the top view showing the example of a configuration of two-step connection of the conventional surface acoustic wave filter.

[Drawing 5] It is the graph which shows the frequency characteristics near [in the surface acoustic wave filter of this invention] the passband.

[Drawing 6] It is the graph which shows the amplitude near [in the surface acoustic wave filter of this invention] the passband, and the unbalance of a phase.

[Drawing 7] It is the graph which shows the frequency characteristics near [in the conventional surface acoustic wave filter] the passband.

[Drawing 8] It is the graph which shows the amplitude near [in the conventional surface acoustic wave filter] the passband, and the unbalance of a phase.

[Drawing 9] It is the electrode block diagram showing typically the surface acoustic wave filter of the one-step configuration concerning this invention.

[Drawing 10] It is the electrode block diagram showing typically the surface acoustic wave filter of the two-step connection concerning this invention.

[Drawing 11] It is the electrode block diagram showing typically the modification of the surface acoustic wave filter concerning this invention.

[Description of Notations]

1,101 : piezo-electric substrate

2, 3, 4, 91, 92,102,103,104 : IDT electrode

5 6,105,106 : IDT inter-electrode part

7,107 : reflector electrode

8,108 : an IDT electrode and reflector inter-electrode part

11,111 : input signal terminal

12,112 : earth terminal

13 15,113,115 : Output signal terminal

21 : Earth Terminal or Electric Float Electrode

22 23 : Ctenidium-like signal electrode

51 71 : Frequency characteristics of an insertion loss

52 72 : Frequency characteristics of VSWR

61 81 : Frequency characteristics of the unbalance of the amplitude

62 82 : Frequency characteristics of the unbalance of a phase

S2, S22, S23 : Signal line of the balanced appearance input section

S3 : Signal line of the unbalance I/O section

d : spacing of an electrode finger center to center

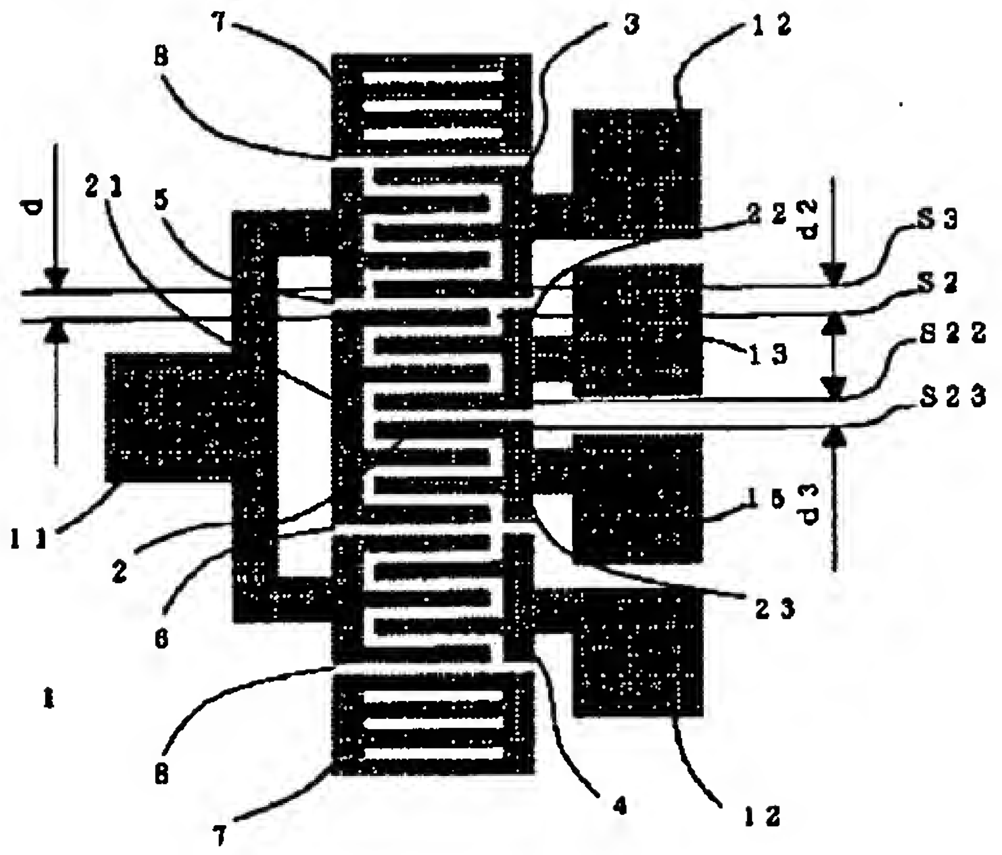
d2 : Spacing of S2 and S3

d3 : Spacing of S22 and S33

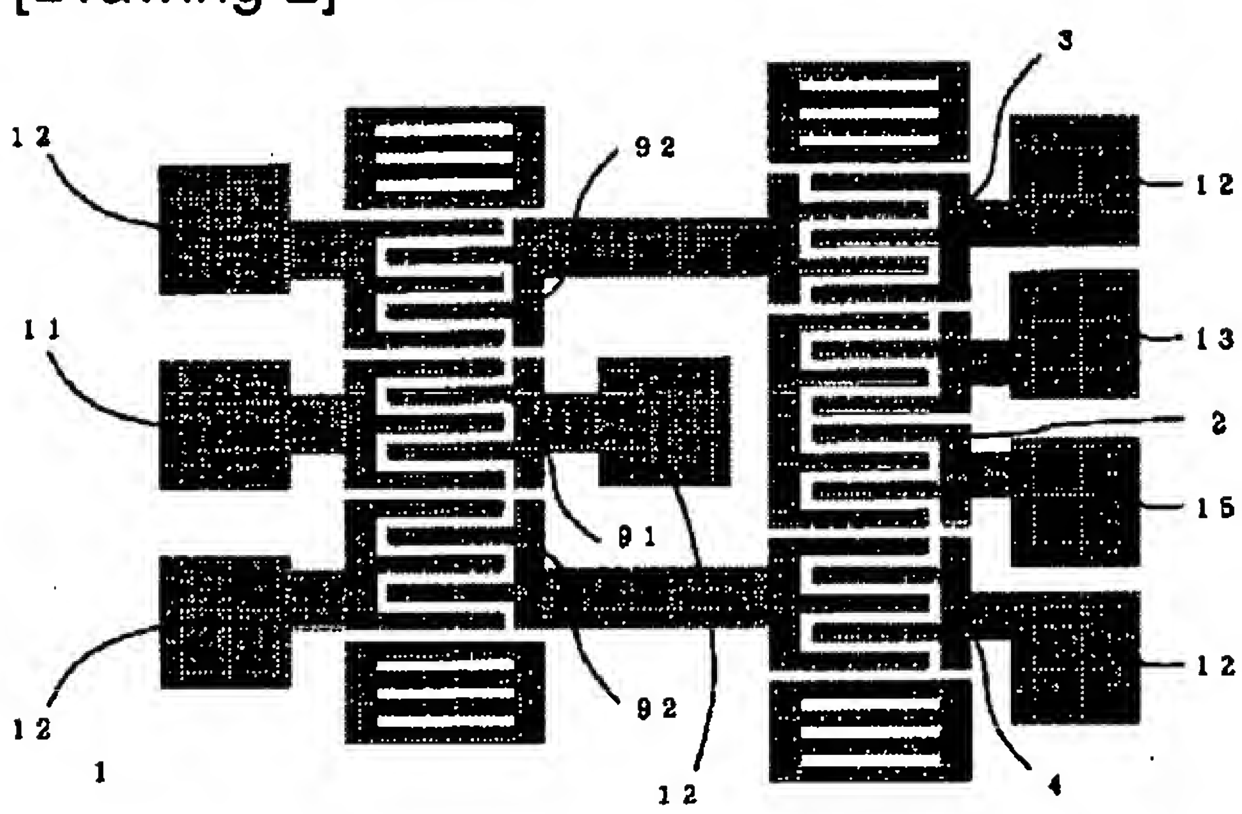
[Translation done.]

DRAWINGS

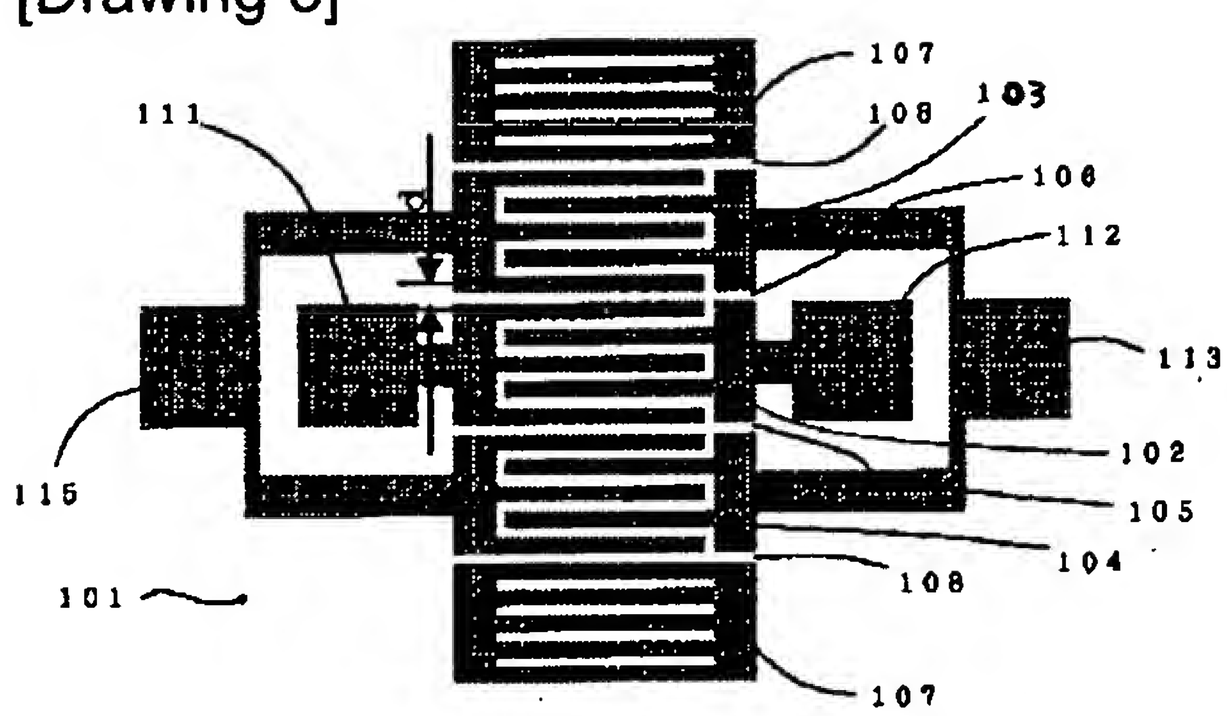
[Drawing 1]



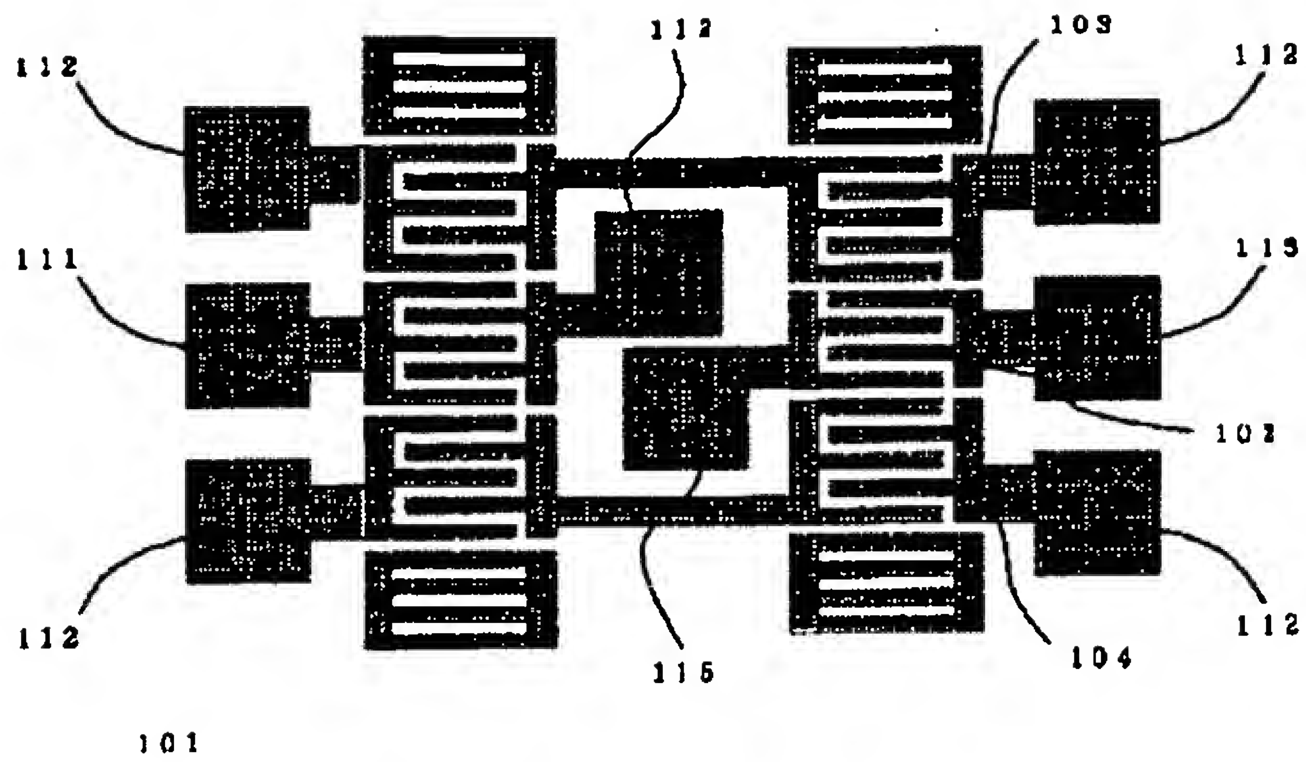
[Drawing 2]



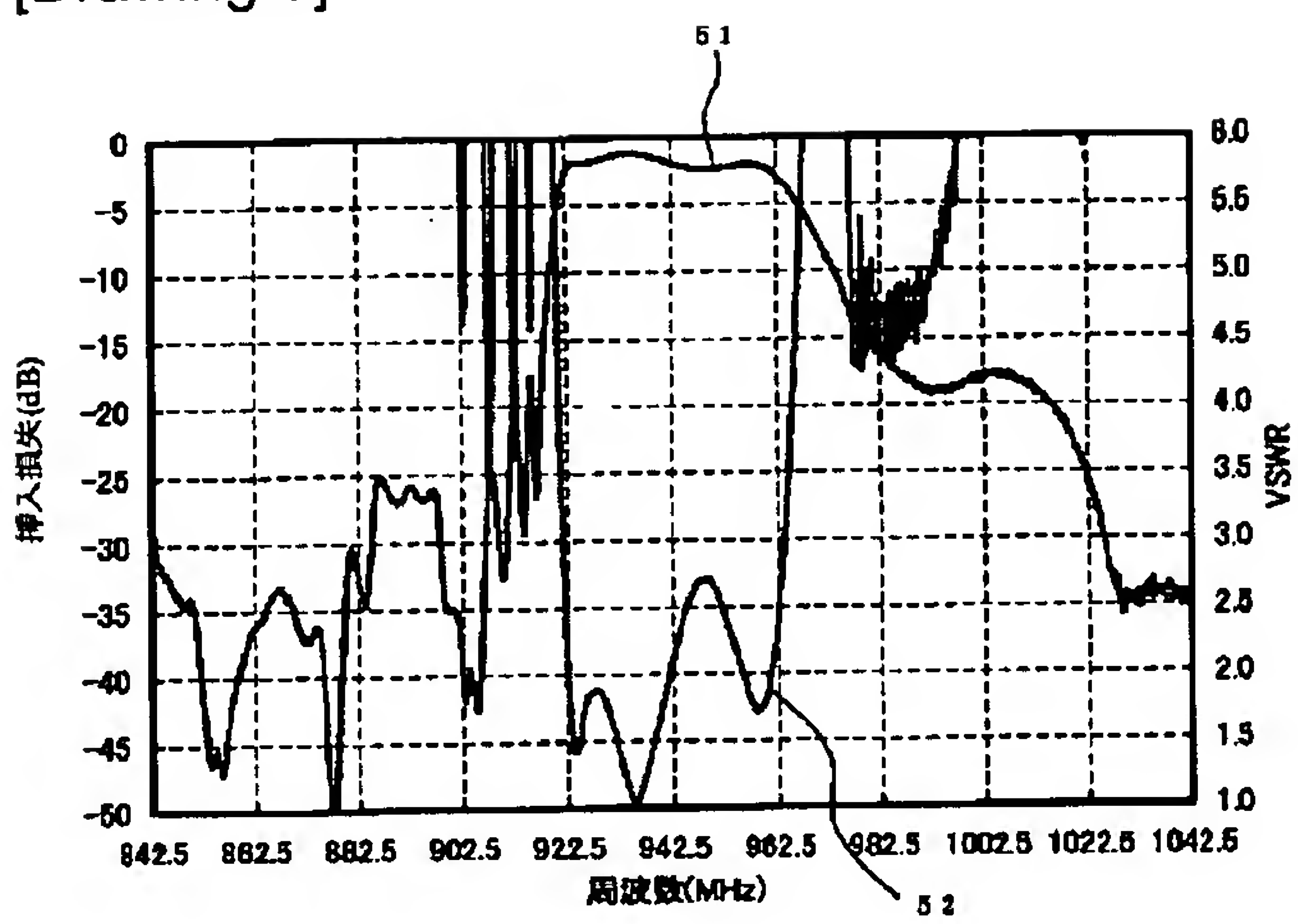
[Drawing 3]



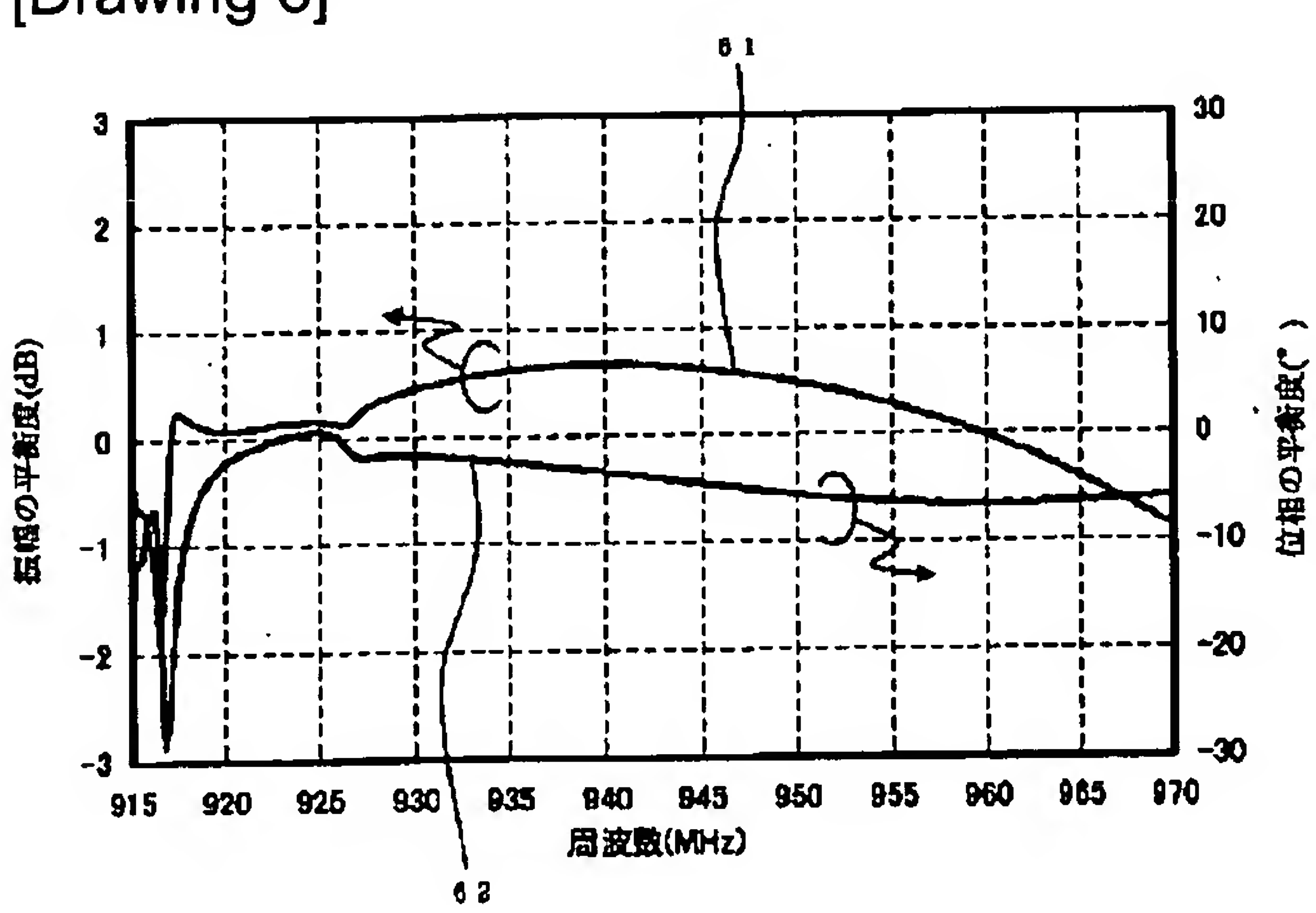
[Drawing 4]



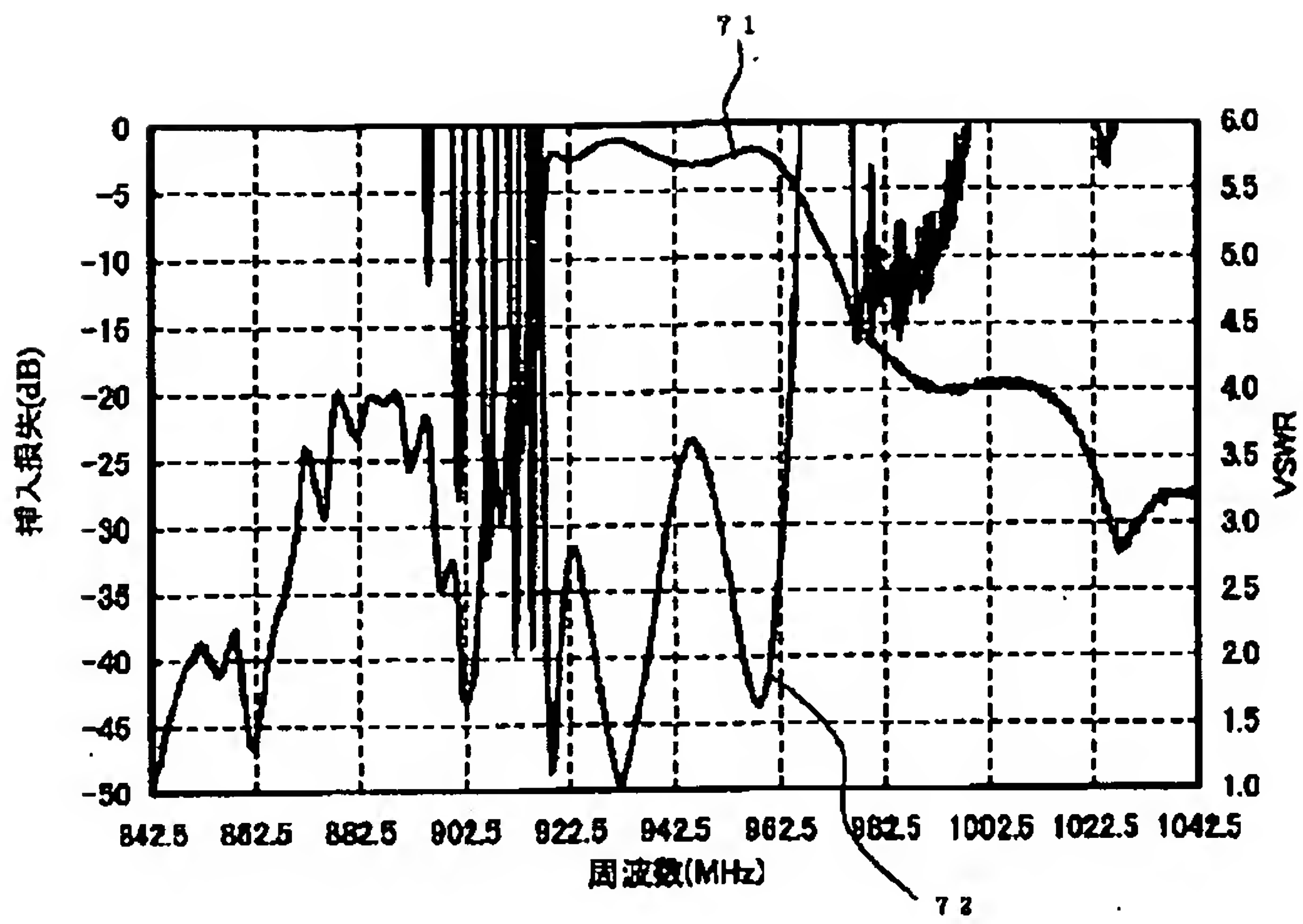
[Drawing 5]



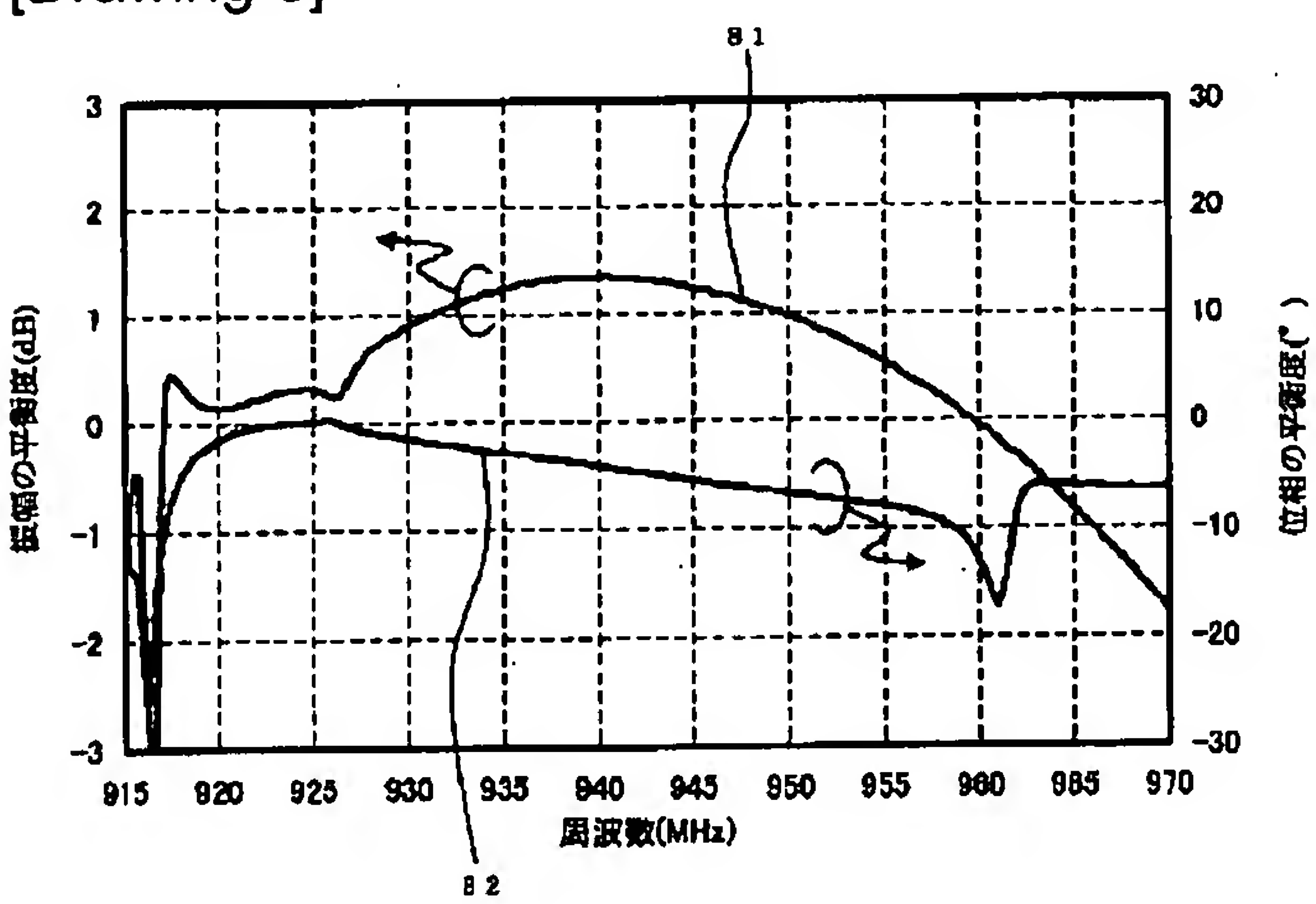
[Drawing 6]



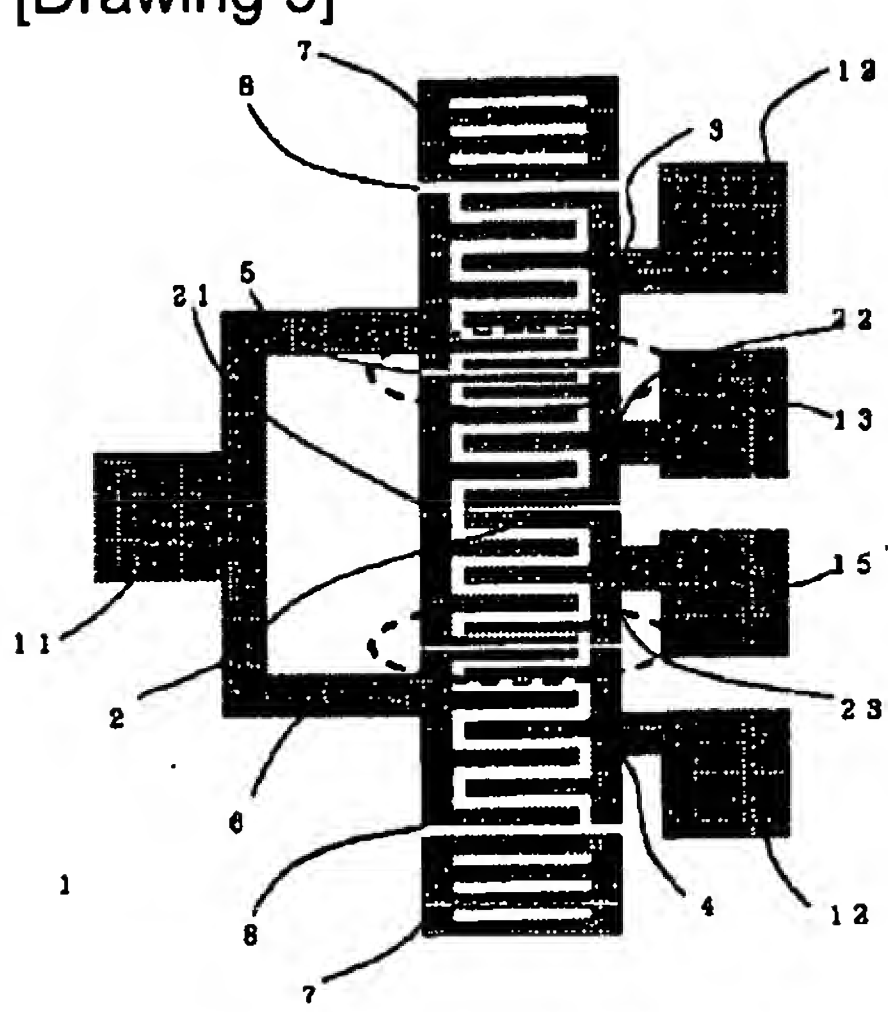
[Drawing 7]



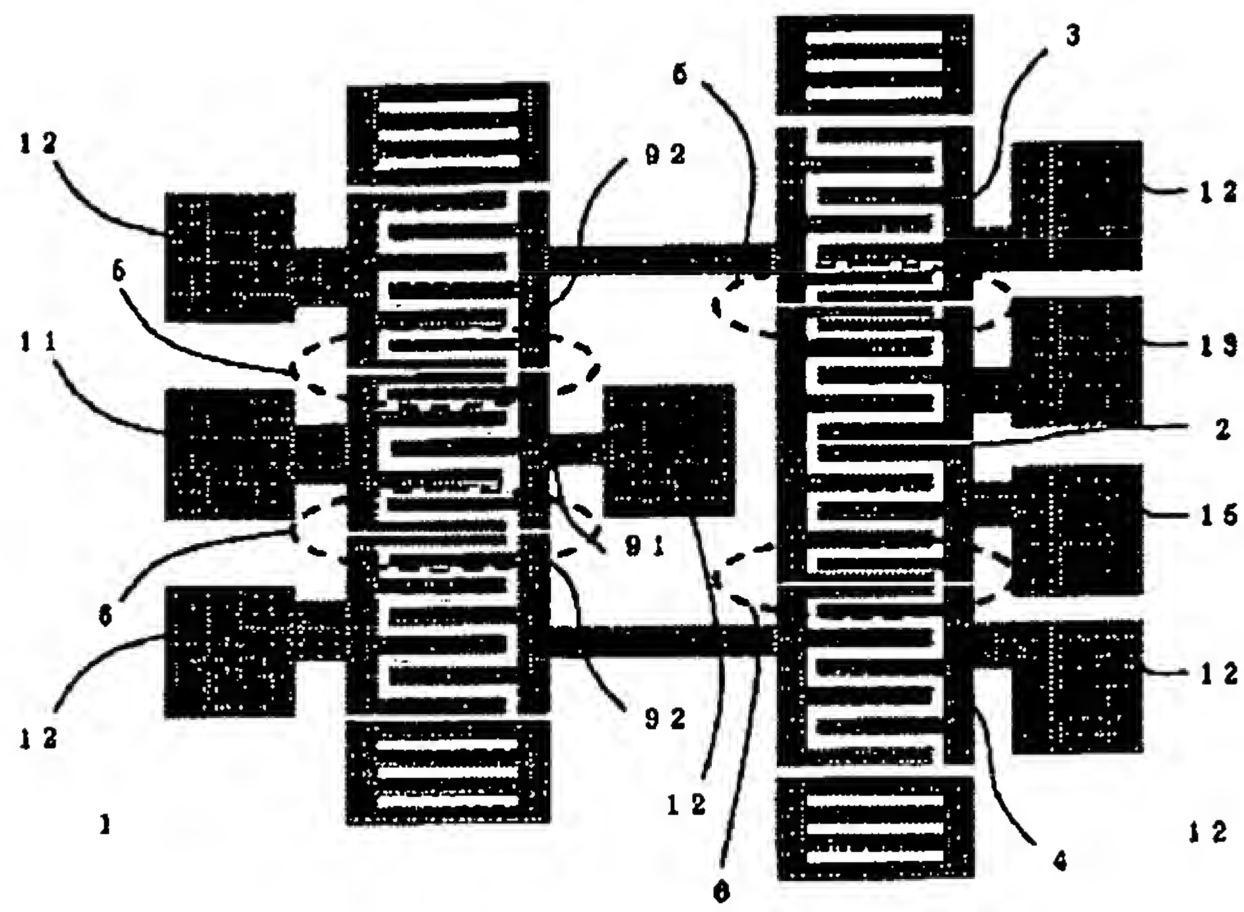
[Drawing 8]



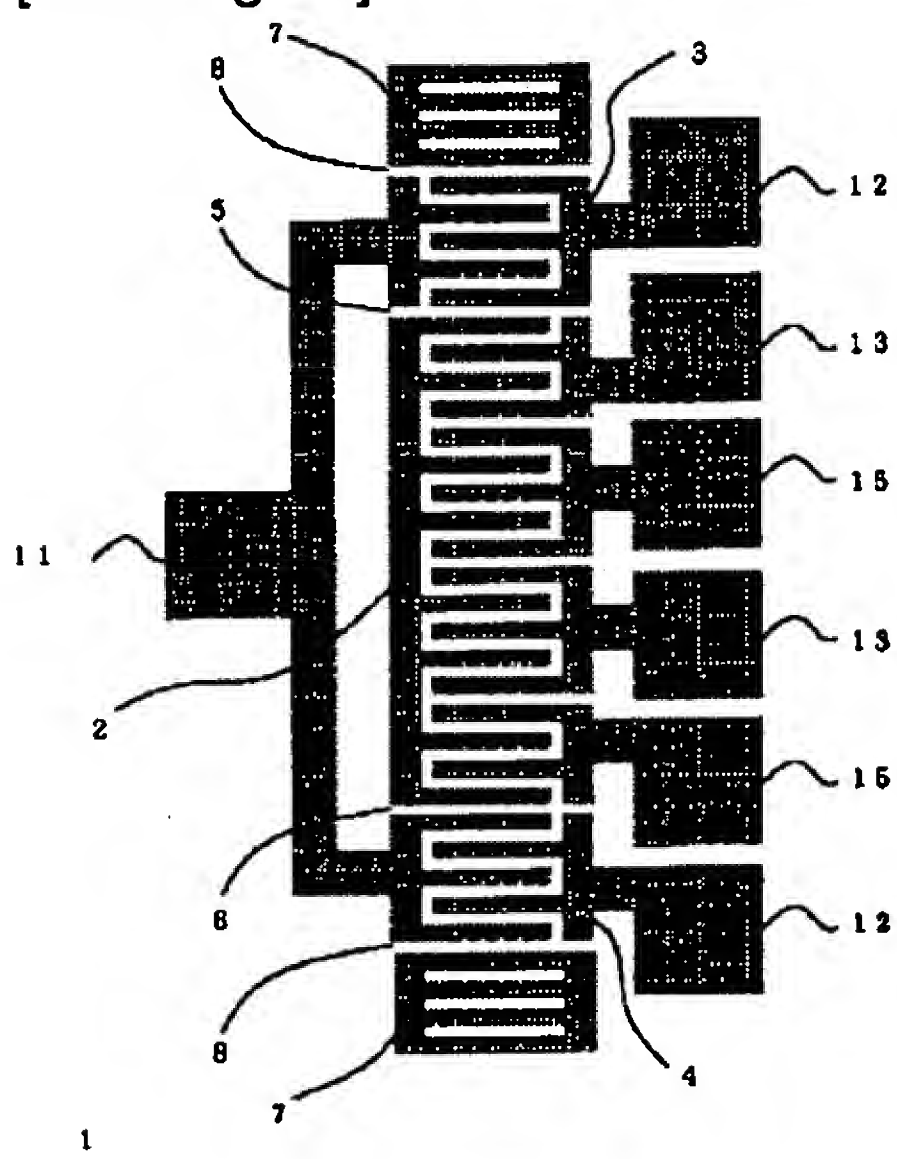
[Drawing 9]



[Drawing 10]



[Drawing 11]



[Translation done.]